[COMMITTEE PRINT]

# SCIENCE POLICY STUDY
# BACKGROUND REPORT NO. 1

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# A HISTORY OF SCIENCE POLICY IN THE UNITED STATES, 1940–1985

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## REPORT

PREPARED FOR THE

## TASK FORCE ON SCIENCE POLICY

## COMMITTEE ON SCIENCE AND TECHNOLOGY
## HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

SECOND SESSION

**Serial R**

SEPTEMBER 1986

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*Ranking Republican Member.
**Serving on Committee on the Budget for 99th Congress.

# LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
*Washington, DC, March 4, 1986.*

*To the Members of the Task Force on Science Policy:*

An important part of the Science Policy Study which our Task Force is conducting in the 99th Congress involves a number of background studies commissioned to assist us in our review.

I am glad to submit the first in this series of background studies which is entitled "A History of Science Policy in the United States, 1940–1985". This study provides a useful overview of how the relationship between the Federal Government and science has evolved over the last 45 years. After a brief survey of the pre-1940 period, the study covers the massive build-up of Federal science support during World War II. It then provides a series of chapters that describe the many developments, incidents and personalities that have shaped the Government-science interface with which we find ourselves faced today. The study is followed by a more detailed chronology of science policy developments going back to the Constitutional Convention of 1787.

To write this study of the history of American science policy, we were fortunate to have serving with the Task Force staff the historian Dr. Jeffrey K. Stine. As a historian, Dr. Stine has specialized in the history of science and government in this country, and he came to the Committee as a Congressional fellow sponsored by the American Historical Association. We are indebted to Dr. Stine and the Association for making it possible to have this important study written for our use. The chronology was compiled for the Task Force by Mr. Michael E. Davey, an analyst and professional staff member of the Science Policy Research Division of the Congressional Research Service in the Library of Congress. Mr. Davey and his colleagues have provided a detailed list of the many important dates and developments that over the last two centuries have constituted the critical events in American science policy.

I commend this study to the attention of every member of the Science Policy Task Force, to the members of the Committee on Science and Technology, and to the members of the House of Representatives who have an interest in matters of science policy and its role in helping to shape the nation's future.

MANUEL LUJAN.
*Ranking Republican Member.*

DON FUQUA,
*Chairman.*

## LETTER OF SUBMITTAL

WATERTOWN, MA, *December 16, 1985.*

Hon. DON FUQUA,
*Chairman, Committee on Science and Technology,*
*House of Representatives, Washington, DC.*

DEAR MR. CHAIRMAN: In its "Agenda for a Study of Government Science Policy," the Science and Technology Committee's Task Force on Science Policy recommended that a history of U.S. science policy be prepared. The history was to provide the Committee with a concise overview of the policy issues and debates that have helped to shape the current relationship between government and science. After spending more than a year with the Task Force, first as an American Historical Association Congressional Fellow and then as an independent consultant, I am pleased to submit that study, entitled "A History of Science Policy in the United States, 1940–1985."

Several people provided critical comments and suggestions during the course of my research and writing. Although I am unable to acknowledge them all, I would like to thank the following for their assistance: David Kite Allison, Harvey Brooks, William D. Carey, Daniel Cornford, A. Hunter Dupree, J. Merton England, Greg Eyring, Paul Forman, Sylvia Doughty Fries, Roger L. Geiger, William T. Golden, Genevieve Knezo, Marcel C. La Follette, Nancy Lindas, A. Michal McMahon, Arthur P. Molella, Allan A. Needell, Carroll W. Pursell, Nathan Reingold, Alex Roland, Marc Rothenberg, H. Guyford Stever, Paul Theerman, and Dael Wolfle.

The Appendix, "Chronology of Federal Executive Branch Science Organization, 1787–1985," was prepared by Michael E. Davey of the Science Policy Research Division of the Congressional Research Service, Library of Congress.

Sincerely yours,

JEFFREY K. STINE,
*Senior Historian, History Associates, Inc.*

# CONTENTS

# I. INTRODUCTION

This study is intended to provide a concise, historical overview of the policy issues and debates that helped to shape the relationship between government and science in the United States since 1940. Because the report addresses the development of national science policy, its focus is on Washington and the policies established within the Executive agencies and Congress. The report pays special attention to the evolution of science policy planning mechanisms, along with the ongoing development of Executive agency science programs and the periodic attempts to coordinate the nation's overall research efforts.[1]

When the House Committee on Science and Technology established its Task Force on Science Policy in the fall of 1984, it was decided that the Task Force would limit its inquiry to issues relating to basic and applied research.[2] This decision was made for practical reasons and in full recognition that a broader definition of science policy would also encompass policies for technological development. Because this history was written as one of several background reports for the Task Force, it, too, will use the more limited definition of science policy, thereby concerning itself primarily with Government support and encouragement of basic and applied research.

Congress plays a special role in allocating money to science because its legislative committees are responsible for setting the budgetary constraints for the various Federal research programs. Incentives and disincentives established by the Federal Government—such as tax credits—also play a major role in the nation's science policy by influencing the amount of support given science by the private sector. Because Federal support of science has mushroomed since World War II, such budget decisions have had profound effects upon the conduct of basic and applied research in this country.

Science policy also involves Government programs for the development and training of scientific personnel. These programs include fellowship and grant support for both graduate students and postdoctorals. In addition, science policy encompasses broader educational policy, especially the support of institutions of higher education. The building and equipping of laboratories are part of this policy. Moreover, science policy includes the controls, safeguards,

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[1] It is not the purpose of this study to provide a narrative history of the internal development of science, the growth of scientific research institutions, or the achievements of individual American scientists since World War II. Nor is it the intent of this study to address the history of policy for engineering development or technology. The focus is on policy for basic and applied research, recognizing that such policy is at times closely linked with technology policy.

[2] See U.S. Congress, House Committee on Science and Technology, Task Force on Science Policy, *An Agenda for a Study of Government Science Policy* (98th Congress, 2nd session. Washington: GPO, 1985), pp. 2–3.

and regulations intended to mitigate the adverse effects—or feared effects—of scientific and technological work.

Despite the complexity of these issues and the difficulty of the allocation decision, no single, formalized science policy has ever been developed within the United States. Nevertheless, even though there is no clearly-stated and coordinated "policy" for science established by the Federal Government, funding and regulatory decisions made by the various agencies involved in research and development have established a *de facto* science policy. The Federal support of science is, and always has been, accomplished through a pluralistic, interrelated system. As Presidential Science Advisor Donald F. Hornig bluntly asserted:

> There are really many national policies for science. So far, the support of science in this country has been based partly on the notion that (via the National Science Foundation) there should be direct support of science as science. But the greater part of our support of science comes from recognizing that, to fulfill the functions of various agencies, we have to support research and development . . . .
>
> Oh, one can talk about a policy, say for support of science in the universities—this is an area that is sufficiently definable to use the word policy. But I don't think a general policy for science will ever exist.[3]

The direction of science in the United States (and other countries as well) was heavily influenced by economic incentives from Government, industry, and private foundations. Since World War II, those incentives have increasingly come from Government. The problems individual scientists chose to study did not always arise purely from their intellectual curiosity. In some instances, scientists simply pursued those research problems that someone had decided to fund. In consequence, greater emphasis has been placed, for example, on cures for cancer than on its prevention—on coal and nuclear energy than on alternative energy sources.

Scholars and decisionmakers have yet to reach a consensus on the extent to which the course of science is socially directed or internally directed. No doubt, it is a complex blend of the two. However, to the extent that the former is true, the nation's science policy takes on a special importance—whether that policy be carefully conceived and planned or be the cumulation of uncoordinated agency policies. Funding patterns and support systems can and do make a big difference in the type of research undertaken.

National science policy has been shaped and formulated within Congress and the Executive Office of the President, frequently with little coordination. Because of the pluralistic nature of the nation's research establishment, the individual Federal agencies have also played a major role in the development of science policy. This study will include some discussion of all these elements, but its particular emphasis will be on the role of Congress.

This history is presented chronologically. Chapter II provides an overview of Government/science relations prior to 1940. Chapter

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[3] Donald F. Hornig, quoted in "White House Superstructure for Science," *Chemical & Engineering News,* 42 (October 19, 1964), 79.

III covers the watershed years of World War II, addressing both the organization of science for the war effort and the planning debates over postwar science policy. The critical postwar years 1945–1950 are discussed in chapter IV, with special attention paid to the development of the Atomic Energy Commission, the Office of Naval Research, and the National Institutes of Health. Chapter V begins with the creation of the National Science Foundation in 1950, and ends in 1957 before the launching of *Sputnik.* The impact of the Soviet earth satellite and the rapid growth of the nation's science program through the mid-1960s are examined in chapter VI. Chapter VII explores the "crisis" in American science policy from the mid-1960s to the mid-1970s, while chapter VIII discusses the changes in Federal science policy which occurred during the Carter and Reagan Administrations.

## II. SCIENCE AND THE FEDERAL GOVERNMENT PRIOR TO 1940

The Federal Government had been a continuous patron of science since the Constitutional Convention of 1787.[1] This support of science came largely through the individual programs of the many Federal bureaus and departments created during the nineteenth and early twentieth centuries. It was not until World War I, however, that large organizational mechanisms were created within the Government in an attempt to coordinate these diverse research and development activities. The wartime organizations were disbanded with the general demobilization in 1919. Other Federal science policymaking mechanisms were experimented with during the New Deal, but it was World War II that saw the vast and permanent expansion in the Government's planning and support of science.[2]

The Federal Government was by no means the only major patron of scientific research prior to World War II. Industry, universities, and private foundations were also substantial supporters of research, and, together with the Federal Government, they formed the four principal sectors of the American scientific establishment. The relative size and proportion of their contributions varied over time, with the Federal Government providing the largest share of funding during the nineteenth century and industry assuming that role in the 1930s. Although their contributions were usually smaller, State Governments were also consistent and important funders of science before 1940.[3]

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[1] The best survey of the Federal Government's support of science before World War II remains A. Hunter Dupree's classic study, *Science in the Federal Government: A History of Policies and Activities to 1940* (Cambridge: Harvard University Press, 1957). See also, Howard S. Miller, *Dollars for Research: Science and Its Patrons in Nineteenth-Century America* (Seattle: University of Washington Press, 1970).

[2] Jean-Jacques Salomon has argued that science policy was a "new field of government responsibility—new in the sense that it was only just after World War II that this field was given institutional recognition through bodies, mechanisms, procedures and a bureaucratic and political staff specifically concerned with these questions." See Jean-Jacques Salomon, "Science Policy Studies and the Development of Science Policy," in Ina Spiegel-Rösing and Derek de Solla Price (eds.), *Science, Technology and Society: A Cross-Disciplinary Perspective* (Beverly Hills: Sage Publications, 1977), p. 43. See also, Kent C. Redmond, "World War II, a Watershed in the Role of the National Government in the Advancement of Science and Technology," in Charles Angoff (ed.), *The Humanities in the Age of Science* (Rutherford: Fairleigh Dickinson University Press, 1968), pp. 166–180.

[3] State Governments have supported science in a number of ways. For examples, see Frederic N. Cleaveland, *Science and State Government: A Study of the Scientific Activities of State Government Agencies in Six States* (Chapel Hill: University of North Carolina Press, 1959): Walter B. Hendrickson, "Nineteenth-Century State Geological Surveys: Early Government Support of Science," *Isis*, 52 (1961), 357–371; and Michele L. Aldrich, "American State Geological Surveys, 1820–1845," in Cecil J. Schneer (ed.), *Two Hundred Years of Geology in America: Proceedings of the New Hampshire Bicentennial Conference on the History of Geology* (Hanover: University Press of New England, 1979), pp. 133–143. See also, Wesley H. Long and Irwin Feller, "State Support of Research and Development: An Uncertain Path to Economic Growth," *Land Economics* (August 1972), 220–227.

## Government Support of Science

Of the four major estates of science—Government, industry, universities, and private foundations—the Federal Government had the longest tradition of funding science. This tradition was rooted in the Constitution, and was expressed in the continuous, if at times modest, public support of research. Over the years, Congress endowed several Federal agencies and departments with the authority to conduct and sponsor research in order that they fulfill their particular missions. As a result, most Government-sponsored research was targeted to promote the national welfare. Public funding of science was justified on utilitarian grounds—that basic research would eventually prove useful for the solution of practical problems.[4] Little or no attention was paid to overall coordination. This fragmented approach to the Government sponsorship of science was a source of both strengths and weaknesses: providing a great deal of flexibility and sources of support, while at the same time resulting in extensive duplication of effort and a lack of effective coordination.

By the early twentieth century, a Federal research establishment was in place which included such agencies and departments as the Weather Service, the Naval Observatory, the Coast and Geodetic Survey, the Geological Survey, the Department of Agriculture, the Bureau of Fisheries, and the Bureau of the Census. The National Bureau of Standards, which was created within the Department of Commerce and Labor in 1901 to meet the Constitutional demand for standards of weights and measures, gained international acclaim for the quality of research conducted at its in-house laboratories. Scientists of various backgrounds were employed throughout these Federal agencies to assist in the carrying out of missions.[5]

### SMITHSONIAN INSTITUTION

Unlike the other Federal agencies that supported science, the Smithsonian Institution was one of the few organizations during the nineteenth century to pursue science for its own sake. Founded in 1846 by the bequest of an Englishman, James Smithson, the Institution's charter called for the "increase and diffusion of knowledge." Headed by eminent scientist-administrators, the Institution played a leading role during the nineteenth century in various aspects of scientific research, including anthropology, biology, geology, and astronomy. Despite the fact that it received Federal appropriations, the Smithsonian was not a Government agency in the strict sense of the word. Rather, it was a private institution under the guardianship of the Government, supplementing its original endowment and annual Federal appropriations with private bequests.[6]

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[4] See George H. Daniels, "The Pure-Science Ideal and Democratic Culture," *Science,* 156 (June 30, 1967), 1699–1705.

[5] For a general discussion of the scientific activities within these various agencies, see Dupree, *Science in the Federal Government,* passim. For an official history of the National Bureau of Standards, see Rexmond C. Cochrane, *Measures for Progress: A History of the National Bureau of Standards* (Washington: GPO, 1966).

[6] See Paul H. Oehser, *The Smithsonian Institution* (New York: Praeger Publishers, 1970).

### NATIONAL ACADEMY OF SCIENCES

The National Academy of Sciences (NAS) was another important quasi-governmental science agency created during the nineteenth century. Founded on 3 March 1863, the NAS was granted a Federal charter as a private organization, and was charged with providing expert scientific advice to the Government. The Academy was to assist any Department of the Government with science-related questions when so requested. Such assistance was to take the form of investigations, examinations, experiments, and reports. Congress was to appropriate funds to cover the actual expense of preparing such studies, but the Academy itself was to receive Federal compensation only for services rendered directly to the Government. It was both a private, nonprofit organization and an official advisory group to the Federal Government.[7]

### THE ALLISON COMMISSION

The dispersed and uncoordinated state of Federal science support led many Members of Congress to consider the possible problems of waste and inefficiency. In 1884, a joint Congressional commission was established to investigate the advantages and disadvantages of reorganizing Federal research activities through the creation of a department of science.[8] Senator William B. Allison of Iowa was made chairman of the Commission, and he promptly requested the National Academy of Sciences to assist the Commission by conducting its own independent study. The Academy report, submitted in September 1884, favored the creation of a Department of Science to conduct research not undertaken at university research laboratories or within private enterprise. Nevertheless, after extensive hearings and debate, the Allison Commission shelved the proposal on the grounds that centralized agencies ultimately did not serve the general welfare of the nation. Moreover, the Commission also recognized that the formation of such a department was not politically feasible.[9]

### IMPACT OF WORLD WAR I

With the Allison Commission's ratification of the status quo, the Federal Government's support of science continued in its fragmented fashion until the demands of World War I prompted American planners to experiment with centralized administration of scientific research. Historically, governments have sponsored the work of scientists and engineers in the hope of obtaining military superiority.[10] Support of research and development typically increased

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[7] See Rexmond Canning Cochrane, *The National Academy of Sciences: The First Hundred Years, 1863–1963* (Washington: National Academy of Sciences, 1978); Nathan Reingold (ed.), *Science in Nineteenth-Century America: A Documentary History* (New York: Hill and Wang, 1964), pp. 200–225; and A. Hunter Dupree, "The National Academy of Sciences and the American Definition of Science," in Alexandra Oleson and John Voss (eds.), *The Organization of Science in Modern America, 1860–1920* (Baltimore: Johns Hopkins University Press, 1979), pp. 342–363.

[8] The agencies under study included the Army Signal Service, the Geological Survey, the Coast and Geodetic Survey, and the Navy's Hydrographical Office.

[9] See Dupree, *Science in the Federal Government*, pp. 215–231.

[10] See William H. McNeill, *The Pursuit of Power: Technology, Armed Force, and Society since A.D. 1000* (Chicago: University of Chicago Press, 1982); and Bernard Brodie and Fawn M. Brodie, *From Crossbow to H-Bomb* (Bloomington: University of Indiana Press, 1973).

during periods of actual warfare, as was exampled in the United States during and after the Civil War.[11] But more than any other conflict before it, World War I punctuated the fundamental application of modern science and engineering to warfare. It became a war influenced heavily by the work of chemists, physicists, and electrical engineers.[12]

Despite the Government-sponsored research and the work of the national laboratories in place on the eve of the war, leaders within both Congress and the Executive Branch recognized the advisability of establishing an institutional mechanism to bring science and engineering more quickly to the service of the Armed Forces. And in so recognizing this, the Government established a large organizational framework to address the planning and development of scientific applications. In 1915, Thomas A. Edison accepted Secretary of Navy Josephus Daniel's invitation to head a new board intended to tap the talents of American inventiveness for the improvement of naval warfare. Created in that year, the Naval Consulting Board (NCB) was charged with soliciting and screening proposals for improved weapons technology. The Board was divided into technical committees on such topics as aeronautics, chemistry, explosives, and ordnance. Although the Board achieved little during the war—it mainly served to review inventions submitted by private inventors—it did serve as the basis for the Naval Research Laboratory, which was created on a permanent basis after the war.[13] Aeronautical research received additional impetus in 1915 with the creation of the National Advisory Committee for Aeronautics, a committee assigned to advise the Government on technological problems related to flight.[14]

With the Naval Consulting Board serving as engineering consultants for the war effort, the National Academy of Sciences proposed the creation of a National Research Council (NRC) that would act as a parallel body of scientific consultants. President Wilson agreed, and in 1916 he established the NRC as an adjunct to the National Academy. The NRC was intended to aid national preparedness by helping the Government to utilize better the services of the professional scientific societies. It was also an attempt to coordinate the work of both government and non-government scientists.

Neither the Naval Consulting Board nor the National Research Council achieved great success in either weapons development or overall policy coordination during the war. Nevertheless, the work of the NCB and NRC contributed to the larger Government experi-

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[11] See Robert V. Bruce, *Lincoln and the Tools of War* (Indianapolis: Bobbs-Merrill, 1956); Nathan Reingold, "Science in the Civil War: The Permanent Commission of the Navy Department," *Isis,* 49 (September 1958), 307–318; and Merritt Roe Smith (ed.), *Military Enterprise and Technological Change: Perspectives on the American Experience* (Cambridge: The MIT Press, 1985).

[12] See Dupree, *Science in the Federal Government,* pp. 302–325; Daniel J. Kevles, "George Ellery Hale, the First World War, and the Advancement of Science in America," *Isis,* 59 (1968), 427–437; Robert H. Kargon, *The Rise of Robert Millikan: Portrait of a Life in American Science* (Ithaca: Cornell University Press, 1982), pp. 82–92; and A. Michal McMahon, *The Making of a Profession: A Century of Electrical Engineering in America* (New York: IEEE Press, 1984), pp. 137–146.

[13] See Lloyd N. Scott, *The Naval Consulting Board of the United States* (Washington: GPO, 1920).

[14] See Alex Roland, *Model Research: The National Advisory Committee for Aeronautics, 1915–1958,* 2 volumes (Washington: National Aeronautics and Space Administration, 1985).

ment in the central administration of scientific research and development, an experience that was to be drawn upon later during the crises of the Great Depression and World War II. The experiences of World War I served to strengthen the links between science, Government, and industry. Moreover, having been recruited to work on defense problems during the war, scientists themselves learned of the importance of the team approach in tackling research problems.[15]

A more concrete legacy of the War was ensured in 1918 when the NRC was perpetuated within the National Academy of Sciences by Executive Order of the President, thus making it a permanent operating arm of the Academy.[16] Yet the organizational and institutional legacy of the scientists' and engineers' wartime efforts was actually quite small owing to the demobilization following the war. The scenario was to be quite different, however, following World War II when wartime scientific organization and leaders remained vital parts of the nation's postwar science policy.

## University Support of Science

If the Federal Government was known for its support of mission-oriented research prior to 1940, then basic research was seen to reside overwhelmingly within the nation's colleges and universities. The association of basic research with universities was, however, a relatively new phenomenon in the early twentieth century. Indeed, the pursuit of scientific research in an organized manner did not begin in earnest within American universities until the late nineteenth century, a period when many new academic institutions were established. During that time, many of the major university laboratories were created and large graduate programs started. By the turn of the century, many of the nation's best and most productive scientists were employed in institutions of higher education. By the 1930s, universities were the undisputed leaders in the conduct of basic research. As an indicator of this, Government, industry, and private foundation support of science often took the form of funding basic research done within the universities.[17]

Yet universities were important centers for the conduct of applied research, most notably in their engineering, medical, and agriculture schools. The agricultural research undertaken at the nation's land-grant colleges was perhaps the most elaborate and successful program of university-supported applied science. These land-grant colleges were established by the Morrill Land-Grant Act of 1862, and received continuous public support through joint Federal and state government funding. The Hatch Act of 1887 further strengthened the research conducted at the land-grant colleges by

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[15] See Robert M. Yerkes (ed.), *The New World of Science: Its Development during the War* (New York: The Century Company, 1920).

[16] Executive Order No. 2859, 11 May 1918.

[17] See Laurance R. Veysey, *The Emergence of the American University* (Chicago; University of Chicago Press, 1965); Charles Weiner, "Science and Higher Education," in David D. Van Tassel and Michael G. Hall (eds.), *Science and Society in the United States* (Homewood, Ill.: Dorsey Press, 1966), pp. 163–189; and Stanley M. Guralnick, "The American Scientist in Higher Education, 1820–1910," in Nathan Reingold (ed.), *The Sciences in the American Context: New Perspectives* (Washington: Smithsonian Institution Press, 1979), pp. 99–141. For the post-World War II period, see Charles V. Kidd, *American Universities and Federal Research* (Cambridge: Harvard Univeristy Press, 1959).

providing Federal support to the establishment of agricultural experiment stations. The Morrill and Hatch Acts thus combined to create a solid link between the Government and institutions of higher learning, a link that later served as a basis for further expansion.[18]

## Industrial Research Laboratories

By the eve of World War II, industry became the predominant funder of scientific research and development in the United States, but that role was a new one for it had not begun supporting science on a large scale until well into the twentieth century. Thomas Edison provided important precedents from the late nineteenth century with the establishment of his famed research laboratory in Menlo Park, New Jersey, in 1876 and his even larger laboratory in West Orange, New Jersey, in 1887. From both laboratories came stories of great successes resulting from the applications of science to invention. These laboratories were the harbingers of a shift in American industry, from a reliance on the lone inventor to the maintenance of organized research laboratories.[19]

Growth in the number of industrial research laboratories was slow up to World War I. The best known laboratories included those at American Telephone and Telegraph, Eastman Kodak, DuPont, Corning Glass Works, and Westinghouse. General Electric's research laboratory, established in 1900, had the distinction of being the first such laboratory to devote its activities primarily to basic, rather than directed, research. Industries such as electrical manufacturing and chemicals found the support of scientific research and development especially profitable, and after World War I the number of industrial research laboratories grew rapidly.[20]

Despite the fact that industrial support of research and development surpassed that of the Federal Government and the universities in the 1930s, industry was not a generous patron of science outside of its own laboratories.[21] Most industrial research was done in-house. And, although some industrial research laboratories were given over to the pursuit of basic research, the vast majority were involved in testing and production. Thus, these laboratories were

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[18] See Margaret W. Rossiter, "The Organization of the Agricultural Sciences," in Alexandra Oleson and John Voss (eds.), *The Organization of Knowledge in Modern America, 1860–1920* (Baltimore: Johns Hopkins University Press, 1979), pp. 211–248; James H. Shideler, "Reflections on Public Support for Agricultural Sciences in the 20th Century," *Working Papers Series*, no. 15 (Davis: Agricultural History Center, University of California, October 1983), pp. 1–27; and Alan I. Marcus, *Agricultural Science and the Quest for Legitimacy* (Ames: Iowa State University Press, 1985).

[19] On Thomas Edison and his research laboratories, see Matthew Josephson, *Edison: A Biography* (New York: McGraw-Hill, 1959); and Robert Conot, *A Streak of Luck: The Life and Legend of Thomas Alva Edison* (New York: Seaview, 1979). See also, Kendall Birr, *Pioneering in Industrial Research* (Washington: Public Affairs Press, 1957).

[20] Brief histories of industrial research are contained in W. David Lewis, "Industrial Research and Development," in Melvin Kranzberg and Carroll W. Pursell, Jr. (eds.), *Technology in Western Civilization*, vol. 2 (New York: Oxford University Press, 1967), pp. 615–634; Carroll Pursell, "Science and Industry," in George H. Daniels (ed.), *Nineteenth-Century American Science: A Reappraisal* (Evanston: Northwestern University Press, 1972), pp. 231–248; and Kendall Birr, "Industrial Research Laboratories," in Reingold, *The Sciences in the American Context*, pp. 193–207. See also, Leonard S. Reich, *The Making of American Industrial Research: Science and Business at GE and Bell, 1876–1926* (Cambridge: Cambridge University Press, 1985).

[21] See Howard R. Bartlett, "The Development of Industrial Research in America," in National Resources Planning Board, *Research—A National Resource*, vol. 2 (Washington: GPO, 1940), pp. 19–77.

used primarily to support the manufacturing process, rather than to generate new knowledge.

### Private Foundations and the Support of Science

Private foundations constituted the fourth major source of research funding in the United States. The Carnegie Institution of Washington and the Rockefeller Foundation were the two most prominent and well-endowed private foundations supporting science early in the twentieth century. They were joined by another major funder in the mid-1920s, the John Simon Guggenheim Foundation. These foundations used both institutional and individual grants in their support of science—methods that were later adopted by the Federal Government. The fellowships awarded by the foundations during the 1920s allowed hundreds of scientists to pursue their research projects unencumbered by the routines of undergraduate teaching and academic administration, for periods ranging from one to four years. Private foundations also supported research through the provision of complex and expensive scientific equipment such as telescopes and, later in the 1930s, cyclotrons.[22]

### Science Policy During the 1920's

The Government's research policy during the decade 1919–1929 reflected the nation's overall transition to a peacetime economy as well as a retreat from the interventionist policies of the Progressive Era. After its brief experiment with central scientific organizations during World War I, the Federal Government resumed its support of mission-oriented research through the separate programs of its many agencies and departments. The National Research Council, through the financial support of the Rockefeller Foundation, began offering postdoctoral fellowships in physics and chemistry in order to stimulate basic research in the United States. The NRC also attempted to coordinate the nation's scientific societies, and sought to stimulate interaction among scientific leaders from universities, Government, industry, and foundations. But the NRC's formal link with the Government weakened during the course of the 1920's, thus making it neither an effective advisor to the Federal Government nor a central organization capable of coordinating the science programs of the various Government bureaus.[23]

Despite the demobilization that took place after World War I, the military continued its scientific research programs throughout the

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[22] See George W. Corner, *A History of the Rockefeller Institute, 1901–1953: Origins and Growth* (New York: Rockefeller Institute Press, 1964); Howard S. Miller, "Science and Private Agencies," in Van Tassel and Hall, *Science and Society in the United States*, pp. 191–221; Nathan Reingold, "National Science Policy in a Private Foundation: The Carnegie Institution of Washington," in Oleson and Voss, *The Organization of Knowledge in Modern America*, pp. 313–341; Stanley Coben, "American Foundations as Patrons of Science: The Commitment to Individual Research," in Reingold, *The Sciences in the American Context*, pp. 229–247; and Robert E. Kohler, "Science and Philanthropy: Wickliffe Rose and the International Education Board," *Minerva*, 23 (Spring 1985), 75–95.

[23] For a discussion of science in the United States during the 1920s, see Dupree, *Science in the Federal Government*, pp. 326–343; Ronald C. Tobey, *The American Ideology of National Science, 1919–1930* (Pittsburgh: University of Pittsburgh Press, 1971); and Daniel J. Kevles, *The Physicists: The History of a Scientific Community in Modern America* (New York: Alfred A. Knopf, 1978), pp. 155–221.

1920s. The Navy, in particular, was committed to the support of science, and in 1923 it created the Naval Research Laboratory from the roots of the Naval Consulting Board established in 1916. Work at the Naval Research Laboratory was highly innovative, much of it centering on basic research conducted by civilian scientists.[24] The in-house laboratories of the National Advisory Committee for Aeronautics were also able to maintain distinguished research programs during the 1920s, led largely by their civilian scientists and administrators.[25]

## Science Policy During the 1930's

The Great Depression had a profound effect on the support of science in the United States. Government laboratories suffered severe budget cuts during the early years of the Depression, although their funding was restored in the mid- to late-1930s as increased Government spending was used in an attempt to revive the economy.[26] More seriously disrupted was the support given to science by industry, universities, and private foundations. Even though most institutions funding research retained their firm belief in the importance of science, the Depression fed a growing current of criticism that blamed science and technology for much of the nation's economic problems.[27]

### SCIENCE ADVISORY BOARD

As part of his response to the problems of the Great Depression, President Roosevelt created the Science Advisory Board by executive order on 31 July 1933.[28] The Board was to provide the Roosevelt Administration with specific science policy recommendations and to serve as the Government's central scientific organization. It was an experiment initially scheduled to last for two years. The Board received no Federal funding, working instead under the aegis of the National Academy of Sciences and the National Research Council. It consisted of nine members appointed by the President, with Massachusetts Institute of Technology president Karl T. Compton designated as chairman.[29] The Board gained

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[24] See David Kite Allison, *New Eye for the Navy: The Origin of Radar at the Naval Research Laboratory* (Washington: GPO, 1981).

[25] See Roland, *Model Research.*

[26] See Dupree, *Science in the Federal Government,* pp. 344–368; Carroll W. Pursell, Jr., "The Administration of Science in the Department of Agriculture, 1933–1940," *Agricultural History,* 42 (1968), 231–240; and Carroll W. Pursell, Jr., " The Farm Chemurgic Council and the United States Department of Agriculture, 1935–1939," *Isis,* 60 (Fall 1969), 307–317.

[27] See, for example, Carroll Pursell, " 'A Savage Struck by Lightning': The Idea of a Research Moratorium, 1927–37," *Lex et Scientia,* 10 (October–December 1974), 146–161.

[28] Executive Order No. 6238, 31 July 1933. This was supplemented by Executive Order No. 6725, 28 May 1934. For the history of the Science Advisory Board, see Lewis E. Auerbach, "Scientists in the New Deal: A Pre-War Episode in the Relations between Science and Government in the United States," *Minerva,* 3 (Summer 1965), 457–482; Carroll W. Pursell, Jr., "The Anatomy of a Failure: The Science Advisory Board, 1933–1935," *Proceedings of the American Philosophical Society,* 109 (December 1965), 342–351; and Kevles, *The Physicists,* pp. 252–258. Also useful for its contemporary view of the Board and of the overall Government activity in the area of scientific research is Karl T. Compton, "The Government's Responsibilities in Science," *Science,* 81 (April 12, 1935), 347–355.

[29] The other charter members of the Board included W. W. Campbell, Isaiah Bowman, Gano Dunn, Frank B. Jewett, Charles F. Kettering, C. K. Leith, John C. Merriam, and Robert A. Millikan.

broad support from scientists who were concerned with stemming the criticism directed against science during the Great Depression and who viewed the Board as an attempt to show that science could make social and economic contributions. In many ways, it paralleled President Roosevelt's Brain Trust, which was an attempt to utilize experts in the development of public policy. It thus became part of the New Deal's broad movement toward national planning.[30]

The Board sought to help stem the depression by marshaling the results of research. It did this primarily through the establishment of committees that were charged with addressing a wide variety of science-related issues. Despite its success in assisting various Federal agencies with their research programs, the Board received only a six-month extension to its two-year charter before being disbanded. Chairman Compton's recommendation that a permanent science advisory agency be established to succeed the Board went unheeded. According to science historian Daniel Kevles, the Board's "accomplishments, beyond some changes in the programs of a few federal agencies, [were] merely a pile of reports."[31] But the Board did play an important role in the evolution of Federal science advice and science policymaking, as well as provided a lucid experiment in central scientific organization. Another historian of science, A. Hunter Dupree, summarized it this way: "Perhaps its most important contribution was to give a broadening experience to a generation that would have other chances before a decade had elapsed."[32]

## NATIONAL RESOURCES COMMITTEE

The National Resources Board replaced the Science Advisory Board in 1935 as the hub of Federal science planning. The National Resources Committee—as the Board was renamed later that year[33]—actually lacked the status of a central scientific organization because it had no administrative power. But it did have the authority to conduct studies and make recommendations. Its most notable and ambitious study was undertaken in 1937 and dealt with the legal, social, and economic aspects of the entire Federal research establishment, including the social sciences. It also examined research in universities and industry, and concluded that the support of research might well help lead the country out of the depression. Published in three volumes between 1938 and 1941, *Research—A National Resource* was the most comprehensive assessment of scientific research in the United States yet conducted. Despite its thoroughness, the report had little direct impact on the nation's science establishment, in part because of the growing preoccupation with the war in Europe.[34]

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[30] See Otis L. Graham, Jr., *Toward a Planned Society: From Roosevelt to Nixon* (New York: Oxford University Press, 1976).

[31] Kevles, *The Physicists*, p. 258.

[32] Dupree, *Science in the Federal Government*, p. 358. See also, Carroll W. Pursell, Jr., "A Preface to Government Support of Research and Development: Research Legislation and the National Bureau of Standards, 1935–41," *Technology and Culture*, 9 (1968), 145–164.

[33] By 1940 the name had changed again, this time to the National Resources Planning Board.

[34] National Resources Committee, *Research—A National Resource*, 3 volumes (Washington: GPO, 1938-1941). See also, Dupree, *Science in the Federal Government*, pp. 358-361.

## Summary

By 1940, the Federal Government had been funding scientific research in a variety of ways for over 150 years. This pluralistic support of science had been scattered throughout the Government's agencies and departments in an uncoordinated, haphazard fashion. Congress considered, then decided against, creating a Department of Science in the 1880s. Brief experiments with central administration of the Government's research activities took place during World War I and the Great Depression, but no permanent coordinating agency was established. World War II was to alter fundamentally the development of government/science relations. Not only did the Federal Government surpass industry as the predominant patron of scientific research during the war, but new and elaborate funding mechanisms were developed along with major new scientific programs. So, too, did the Government begin an ongoing effort to formulate and define a national policy for science.

## III. SCIENCE DURING WORLD WAR II

Despite the numerous and long-term interactions between science and the Federal Government prior to 1940, World War II nevertheless served as a point of transition in the development of this relationship. The scale of Government support of research climbed dramatically, never to return to the prewar levels. Moreover, the combination of institutions and Federal support systems which existed before 1940 was significantly altered during the course of the war. Another impact of the war was to transform the relationships among government, universities, private foundations, and industry. Of these, the most notable change for science was the strengthening of the link between government and universities, but another important outcome was the establishment of the military as a continuing and generous supporter of scientific research and technological development.

Such fundamental changes in the structure of American science policy were made possible only through the crisis and state of urgency created by the war. It was, in a very real sense, a battle for self-preservation. Winning the war became society's overriding objective, one which created a very special political climate. In the words of political scientist Don K. Price, "Even more than the profit motive of a private corporation, the demand for unconditional victory lets you reduce all issues to questions of means; the ends are not in doubt." [1]

The scientific community became an active participant in the wartime mobilization of national resources. To use research quickly enough to affect the outcome of the war, the Government reorganized existing scientific infrastructure and personnel, thereby avoiding the need to establish new laboratories or train new scientists as was done during World War I. Moreover, because the support given to scientists and engineers was restrained not on financial grounds but only by the limits of personnel and materials, total Government expenditures for scientific research soared. The Government became the principal supporter of research. And although this wartime funding was overwhelmingly for technology and weapons development—that is, for applied rather than basic research—one important outcome was the Government's adoption of an unique contract system with universities and industry, a system later adopted for the support of postwar basic research.

Long before the end of the war, policymakers began thinking about how this new infrastructure would be supported within a peacetime economy. Such thinking was part of the broader planning for postwar reconversion, which began as early as 1943. It was clear that the Office of Scientific Research and Development was a

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[1] Don K. Price, "Science at a Policy Crossroads," *Technology Review*, 73, (April 1971), 35.

temporary agency to be disbanded at the end of the war. At that time, Congress would be asked to decide the future of Federal science support. Few people—scientists or Government officials—desired a return to pre-World War II conditions. Most wanted to maintain the close links between the Government and universities. Many of the issues that have become standard fare for science policymakers during the 40 years after World War II were thus addressed in the debates of this period.[2]

## Office of Scientific Research and Development

This contract system—and the overall coordination of research during the war—was developed largely by the National Defense Research Committee (NDRC) and its successor organization, the Office of Scientific Research and Development (OSRD).[3] These offices provided a new framework for science policy in the United States. Most notably, they tightened the link between universities and Government research. They also brought science policymaking mechanisms directly into the Executive Office of the President.

The urgency of the war lessened the advisability of Congress establishing policy because the nation simply could not afford to wait for legislation. Executive orders under temporary war powers became the norm. A notable example of this rise in Presidential authority was President Roosevelt's establishment of the National Defense Research Committee on 27 June 1940, which was funded through the President's emergency funds. By coordinating the nation's nonmilitary science resources, the NDRC attempted to supplement the weapons development programs being carried out directly by the Army and Navy. It became the key to the formulation of a deliberate wartime science policy.

In establishing the NDRC, Roosevelt was responding to the recommendations made to him by Vannevar Bush, whom Roosevelt promptly appointed chairman of the new Committee. Bush, the son of a Universalist minister, grew up near Boston and attended Tufts College as an undergraduate. In 1916 he was awarded a doctorate in electrical engineering from a joint Harvard University/Massachusetts Institute of Technology program. Working briefly during World War I on problems related to submarine detection, Bush joined the faculty of M.I.T., where he remained for twenty years. He left his post as vice president and dean of engineering at M.I.T.

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[2] A good summary of these debates are presented in National Academy of Sciences, *Federal Support of Basic Research in Institutions of Higher Learning* (Washington: National Research Council, 1964), pp. 1–56. The original draft of this section of the Academy report was written by A. Hunter Dupree. See also, James L. Penick, Jr., Carroll W. Pursell, Jr., Morgan B. Sherwood, and Donald C. Swain (eds.), *The Politics of American Science: 1939 to the Present* (Cambridge: The MIT Press, 1972); and J. Merton England, *A Patron for Pure Science: The National Science Foundation's Formative Years, 1945–57* (Washington: National Science Foundation, 1982).

[3] For the history of NDRC and OSRD, see James Phinney Baxter III, *Scientists Against Time* (Boston: Little, Brown, 1946); Irwin Stewart, *Organizing Scientific Research for War: The Administrative History of the Office of Scientific Research and Development* (Boston: Little, Brown 1948); A. Hunter Dupree, "The Great Instauration of 1940: The Organization of Scientific Research for War," in Gerald Holton (ed.), *The Twentieth-Century Sciences: Studies in the Biography of Ideas* (New York: W.W. Norton, 1972), pp. 443–467; and Carroll Pursell, "Science Agencies in World War II: The OSRD and Its Challengers," in Nathan Reingold (ed.), *The Sciences in the American Context: New Perspectives* (Washington: Smithsonian Institution Press. 1979), pp. 359–378. Perhaps the best short description of the accomplishments of the OSRD is George H. Daniels, "Office of Scientific Research and Development," in Donald R. Whitnah (ed.), *Government Agencies* (Westport: Greenwood Press, 1983), pp. 426–432.

in 1938 to accept the presidency of the Carnegie Institution in Washington, D.C. Because the Carnegie was at that time the nation's largest private research organization outside the universities, the appointment gave Bush entrée into the highest levels of national scientific research and development policy. He learned how the system worked and who the major players were. He also was made a member of the National Advisory Committee for Aeronautics (NACA), and in the following year was appointed its chairman. That post enhanced Bush's skills as a high-level science administrator, especially his ability to develop and maintain good relations with various governmental agencies and Congress. As the historian Sam Bass Warner explained:

> Bush regarded this panel [NACA] as a model institution. It had power and funds because it reported directly to the president of the United States; it was not merely an advisory committee outside the federal budget and bureaucracy, as many of the technological committees had been during World War I.[4]

Bush used these positions in Washington to propel himself into wartime planning, appealing at an early stage to mobilize civilian scientists and engineers for the development of new weapons for the war. With NACA as his organizational model, Bush pushed for a centralized research effort headed by civilian scientists and engineers not military officers. He was assisted in this effort by three leaders within the scientific community: Harvard president James B. Conant; National Academy of Sciences president and Bell Telephone Laboratories director Frank B. Jewett; and M.I.T. president Karl T. Compton. Besides being eminent spokesmen, these men represented the main sectors of U.S. scientific activity.

The politically conservative Bush had not supported the New Deal, preferring instead the approach of his fellow engineer, Herbert Hoover. Consistent with this political approach, therefore, he disapproved of Government restraints on business, a bias that was later to influence his conception of postwar science policy.[5]

As chairman of NDRC, Bush served as the liaison person between science and the White House, Congress, and the armed services. He organized the Committee into five divisions, each chaired by a civilian member. These divisions corresponded to broad, general-purpose research areas: ordnance, chemistry and explosives, communications and transportation, instruments and controls, and patents and inventions. Each division could create as many sections as it deemed necessary to address specific research problems. The NDRC also incorporated the Advisory Committee on Uranium, which had been established by President Roosevelt in 1939.

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[4] Sam Bass Warner, Jr., *Province of Reason* (Cambridge: Belknap Press of Harvard University Press, 1984), pp. 196–197. See also, Alex Roland, *Model Research: The National Advisory Committee for Aeronautics, 1915–1958*, 2 volumes (Washington: National Aeronautics and Space Administration, 1985).

[5] For comments on Bush's political conservatism, see Nathan Reingold, "Vannevar Bush's New Deal for Science, or the Counter-Revolution of the Old Order," unpublished manuscript in author's possession; and Daniel J. Kevles, *The Physicists: The History of a Scientific Community in Modern America* (New York: Alfred A. Knopf, 1978), p. 295.

In June 1941, the NDRC was expanded to become the OSRD,[6] largely because of the limitations Bush saw in the NDRC. NDRC's authority was to conduct research on new military devices. However, it could not proceed with development, even on the scale of prototypes. Moreover, it was not fully integrated into the overall weapons research planning conducted within the armed services. Bush favored the establishment of a separate, independent Federal organization that could obtain independent funding through Congressional appropriations, rather than be limited to Presidential emergency funds. In addition, Bush believed the head of such an organization should have direct access to the President. He also thought the agency should include military medical research, something that the NDRC lacked.[7]

The OSRD was placed within the Office of Emergency Management, under the protection of the White House. It was given its own budget, and, as chairman, Bush was given direct access to the President, making him in effect Roosevelt's personal science advisor. The OSRD's purpose was to provide adequate scientific research for purposes of national defense, including medical problems, which were handled through OSRD's Committee on Medical Research. The NDRC was made a committee of the new OSRD, and James B. Conant succeeded Bush as its chair. The OSRD was intended to last only for the duration of the war—a point that Bush frequently made. And its efforts were to be practical—to provide new weapons for this war, not the next. The scientists organized under Bush were conducting directed, not basic research.

Bush and the members of the OSRD attempted to avoid disrupting the existing scientific structure. Reliance was placed on management and coordination, and research projects already undertaken by the Army and Navy were left in place. Supporting and expanding the existing system was seen as the quickest and most fruitful approach to mobilizing science and engineering for the war effort. Civilian scientists and engineers did not, therefore, don military uniforms as they had done during World War I. There was less emphasis placed on establishing new Government laboratories than there was during World War I, although some were created for the top-secret Manhattan Project. These laboratories were not operated by the OSRD, however. The emphasis was on utilizing the existing research teams and facilities located in the nation's universities and business laboratories, largely through the use of contracts. One example of such a laboratory, and perhaps the most well-known, was the Radiation Laboratory at M.I.T. where much of the work on the development of radar was centered.[8] Like many of these research establishments and the OSRD itself, the MIT Radiation Laboratory was to produce a number of prominent leaders in American science policy during the post-war era.

The OSRD was tremendously successful in applying science, engineering, and medicine to the conduct of the war. Moreover, while it attempted not to disrupt the existing arrangements for research,

[6] Executive Order No. 8807, 28 June 1941.
[7] See Kevles, *The Physicists*, p. 299.
[8] Ernest C. Pollard, *Radiation: One Study of the MIT Radiation Laboratory* (Durham, N.C.: Woodburn, 1982).

the OSRD did provide profound and far-reaching precedents for the future organization of science in the United States. The contract system was so successful during the war that it set a pattern for postwar American science policy which remains to this day.[9]

### The Manhattan Project

The development of the atomic bomb under the aegis of the Manhattan Project was the most touted accomplishment of the scientists and engineers working during the war, and it too had a profound impact on later developments in science policy and the overall relationship between science and Government in the United States. The wartime atomic energy research program began in 1939 with Roosevelt's creation of the ad hoc Uranium Committee. This Committee, along with the NDRC, was absorbed in 1941 to create the OSRD. Due to stringent security requirements and the realization that this was a large-scale operation beyond the bounds of the OSRD, Bush transferred the OSRD atomic weapons program to the Army's Manhattan Project in 1943. After the war, nuclear research remained an issue separate from the rest of the nation's science policy—largely because of its overwhelming military implications.[10]

### Funding Mechanisms and the Legacy of World War II

Besides the permanent rise in Federal expenditures for research and the strengthened ties between Government and the nation's leading research universities, World War II ushered in another fundamental change for American science policy—the installation of two types of research funding mechanisms, contracts and grants. Vannevar Bush preferred the research contract as the predominant method of funding science. First developed by NACA, and then elaborated on by OSRD, the contract system became important for postwar funding when it was adopted by the Office of Naval Research, one of the largest supporters of basic research during the five years after the war.

The research grant, the other major funding mechanism used during World War II, was the system favored by the universities and perhaps by the majority of principal investigators. It tended to provide greater freedom and latitude. After the war, the National Institutes of Health utilized the grant system extensively. Indeed, until specific legislation was passed to help higher education after *Sputnik,* the grant system served as a type of covert aid to higher

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[9] For a complete account of the accomplishments of the OSRD, see the nine volumes of the official "Science in World II Series": Baxter, *Scientists Against Time;* Stewart, *Organizing Scientific Research for War;* John E. Burchard (ed.), *Rockets, Guns and Targets* (Boston: Little, Brown, 1948); Joseph C. Boyce (ed.), *New Weapons for Air Warfare* (Boston: Little, Brown, 1947); William A. Noyes, Jr. (ed.), *Chemistry: A History of the Chemistry Components of the N.D.R.C., 1940–1946* (Boston: Little, Brown, 1948); Chauncy G. Suits, Louis Jordan, and George R. Harrison (eds.), *Applied Physics: Electronics, Optics, Metallurgy* (Boston: Little, Brown, 1948); Lincoln R. Thiesmeyer and John E. Burchard, *Combat Scientists* (Boston: Little, Brown, 1947); E. C. Andrus, Detlev W. Bronk, et al., *Advances in Military Medicine,* 2 volumes (Boston: Little, Brown, 1948); and Charles W. Bray, *Psychology and Military Proficiency: A History of the Applied Psychology Panel of the N.D.R.C.* (Princeton: Princeton University Press, 1948).

[10] See Richard G. Hewlett and Oscar E. Anderson, Jr., *The New World, 1939-1946: Volume I, A History of the United States Atomic Energy Commission* (University Park: Pennsylvania State University Press, 1962).

education, becoming part of the informal means of dealing with the scientific personnel problem.

For science, especially science in the universities, one of the main consequences of World War II was that it made research and development big business. It also bound this R&D—done at both industrial labs and universities—to the Federal Government. It established a wartime pattern of centrally administered research.

The research and development undertaken during World War II led to many new technologies that played a fundamental role in the outcome of the war. The most significant contributions included the atomic bomb, proximity fuse, computer, jet plane, penicillin, and DDT. The success and importance of these developments convinced political, military, and scientific leaders of the value of a continuing military research program. Indeed, the link between new technologies and military strength became so strong that the Federal Government could no longer leave science to its own devices.

### Military Research

Spurred largely by the wartime successes of the OSRD and the arguments of senior scientific spokesmen like Bush, U.S. military and political leaders came to adopt the view that if the United States wanted to maintain its technological military superiority, then substantial investments in basic research were required. Military planners became committed to keeping and building up their scientific research programs after the war. Each branch of the armed services sought to maintain some sort of scientific research and development capability. The Navy, for example, began planning during this period for the eventual creation of the Office of Naval Research. Despite its ultimate concern with applications and development, the military took the lead during the postwar era in supporting basic research on an unprecedented scale. There was little controversy over whether the military should fund such research. The debate centered on whether military research would remain under civilian control, as it had been with the OSRD, or would revert entirely to control by the armed services.

The question of total military control of scientific secrecy and security after the war also concerned science policymakers. It was not so much a problem for the classified and applied research conducted within the Government laboratories as it was for military-supported research performed by scientists on university faculties.

### Meeting Postwar Scientific Personnel Needs

During the war, university graduate education was virtually suspended almost everywhere in the world. The resulting shortage of new scientific personnel thus became a major concern for the makers of postwar science policy. From the Government's perspective, this scientific personnel shortage was seen as both a military and civilian problem.[11] Great attention was therefore paid to the

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[11] One unusual method proposed to meet this need was Project Paperclip, a successful effort to bring German scientists and technicians to the United States after World War II. The pur-

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nation's educational system and especially to strengthening graduate science programs at the major research universities.

## Congress and Science Policy

Congressional involvement in the formation of science policy during the war was most vigorously pursued within the Senate Committee on Military Affairs. Senator Harley M. Kilgore, Democrat of West Virginia and chair of the Subcommittee on War Mobilization, headed this effort by arranging a series of hearings in 1942, 1943, and 1945 on the general issue of Government support of scientific research and development.[12] The 1942 hearings were concerned with organizing the nation's technological talent for the purpose of assisting the war effort. Kilgore introduced legislation at that time to create an Office of Technological Mobilization. Kilgore expanded these goals to science in 1943 when he submitted a Science Mobilization bill. His 1945 hearings were conducted after the end of the war, at which time he introduced legislation to create a National Science Foundation.

Kilgore was a staunch supporter of the New Deal and was interested in the linkage of scientific research to industry. He was also interested in the issue of geographical distribution of scientific research funding. Because the OSRD had not concerned itself with either geographical distribution or industrial research—nor with the sciences, such as biology and geology, that did not fit squarely within the war effort—the Kilgore subcommittee concentrated on the creation of a broader science organization to replace the OSRD after the war. Herbert Schimmel, a physicist on the subcommittee staff, was instrumental in shaping the hearings and legislation put forth by Kilgore. Knowing that the OSRD would be disbanded after the war, Kilgore proposed the creation of a central agency to deal with matters relating to scientific research and development. This plan was presented in his subcommittee's 1945 report, *The Government's Wartime Research and Development,* known widely as the "Kilgore Report." [13]

## The Bush Report

The Kilgore hearings naturally aroused the interest of Vannevar Bush and other leaders of the scientific community. This was especially true because of Bush's strong disagreement with many aspects of Kilgore's proposals. Indeed, because there was a fundamental shift of scientific support in the offing, the scientists had an important stake in entering the public debate, if not in presenting a

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poses of the project were: (1) to deny this scientific and technical expertise to the Russians; and (2) to benefit American interests, primarily in military applications. Ultimately, 642 German scientists and technicians were brought to the United States under the auspices of the project, many of them coming after 1948. See Clarence G. Lasby, *Project Paperclip: German Scientists and the Cold War* (New York: Atheneum, 1971).

[12] See U.S. Congress, Senate Committee on Military Affairs, Subcommittee on War Mobilization, *Scientific and Technological Mobilization,* (78th Congress, 1st session. Washington: GPO, 1943); and U.S. Congress, Senate Committee on Military Affairs, Subcommittee on War Mobilization, *The Government's Wartime Research and Development, 1940–1944* (79th Congress, 1st session. Washington: GPO, 1945).

[13] See England, *A Patron for Pure Science,* p. 3; and Robert F. Maddox, "The Politics of World War II Science: Senator Harley M. Kilgore and the Legislative Origins of the National Science Foundation," *West Virginia History,* 41 (Fall 1979), 20–39.

program of their own. The Office of Scientific Research and Development became the principal mechanism for this when, on 17 November 1944, President Roosevelt sent Bush a letter requesting him to prepare a report on how the nation should support scientific research after the war. Noting that the OSRD represented "a unique experiment of team-work and cooperation in coordinating scientific research and in applying existing scientific knowledge to the solution of the technical problems paramount in war," Roosevelt wrote that there was "no reason why the lessons to be found in this experiment cannot be profitably employed in times of peace." [14]

Roosevelt asked Bush to provide him with recommendations on four major points. Bush responded by appointing four committees to investigate the various areas of scientific research and to report their recommendations to him. The committees included the Medical Advisory Committee chaired by W. W. Palmer, the Committee on Science and the Public Welfare chaired by Isaiah Bowman, the Committee on Discovery and Development of Scientific Talent chaired by Henry Allen Moe, and the Committee on Publication of Scientific Information chaired by Irvin Stewart. These reports reached Bush by June 1945, and were appended to his final report, *Science—The Endless Frontier,* which was submitted to President Truman on 5 July 1945.

Bush was politically astute; he knew what language and arguments would gain support. His report was a plea for Federal Government support of science, one that attempted systematically to justify public expenditures for science. He was also skilled at providing a politically-palatable rationale. The rhetoric of American government continually advancing frontiers is but the most obvious example. He wisely tied Federal support of science to such basic national issues as defense, public health, and economic growth and stability, claiming in his introduction:

> Advances in science when put to practical use mean more jobs, higher wages, shorter hours, more abundant crops, more leisure for recreation, for study, for learning how to live without the deadening drudgery which has been the burden of the common man for ages past. Advances in science will also bring higher standards of living, will lead to the prevention or cure of diseases, will promote conservation of our limited national resources, and will assure means of defense against aggression.[15]

Bush went on to argue:

> It has been basic United States policy that Government should foster the opening of new frontiers. It opened the seas to clipper ships and furnished land for pioneers. Although these frontiers have more or less disappeared, the

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[14] Franklin D. Roosevelt to Vannevar Bush, 17 November 1944, reprinted in Vannevar Bush, *Science—The Endless Frontier: A Report to the President* (Washington: GPO, 1945), pp. 3-4. For the preparation of this report, see J. Merton England, "Dr. Bush Writes a Report: 'Science—The Endless Frontier'," *Science,* 191 (January 9, 1976), 41-47; and Daniel J. Kevles, "The National Science Foundation and the Debate over Postwar Research Policy, 1942-1945: A Political Interpretation of *Science—The Endless Frontier,*" *Isis,* 68 (March 1977), 5-26.

[15] Bush, *Science—The Endless Frontier,* p. 10.

> frontier of science remains. It is in keeping with the American tradition—one which has made the United States great—that new frontiers shall be made accessible for development by all American citizens.[16]

If the United States was to be prepared for any future war, Bush argued, then science must play a crucial role within such preparation. This was especially true because modern warfare was becoming increasingly science-based. Bush also tied scientific research to the nation's quest for full employment—an issue that concerned many of the President's domestic policy planners.

Bush absorbed into his report a concept widely held as a truism by physical scientists: that basic scientific research provides the underpinning for all major technological advances. According to Bush:

> Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science.[17]

Many Government planners feared that the close of World War II might bring about vast economic dislocations, perhaps to the extent of precipitating another depression. Bush played to this concern by arguing that Government support of basic research would help the nation avoid such problems; it would create new, science-based industries and, along with this, new jobs. Bush and other proponents of Federally-supported research consistently emphasized the great benefits to the peacetime economy to be derived from such a policy.

In addition, Bush stressed the need for "scientific capital," and the advisability of not looking to Europe for that capital as the United States had been required to do before the war. In order to replenish the deficit of scientists and engineers caused by the disruption of World War II and to ensure the continued training of adequate numbers of scientists and engineers, Bush recommended that the Federal Government establish a system of scholarships and fellowships at both the graduate and undergraduate levels.

In providing the rationale for the public financing of science, Bush argued that the Government should support science financially, but that the scientists should be allowed to maintain control over the content of the research. It was a question of funding versus control. To the extent that Bush was in disagreement with the proposals put forth by Senator Kilgore, he used this report to set forth his own ideas.[18]

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[16] *Ibid., p. 11.*

[17] Bush, *Science—The Endless Frontier,* p. 19. For a discussion of the arguments linking science to technological progress, see E. Layton, "Conditions of Technological Development," in Ina Spiegel-Rösing and Derek de Solla Price (eds.), *Science, Technology and Society: A Cross-Disciplinary Perspective* (Beverly Hills: Sage Publications, 1977), pp. 197–222; and John P. McKelvey, "Science and Technology: The Driven and the Driver," *Technology Review,* 88 (January 1985), 38–47.

[18] See Office of Technology Assessment, *The Regulatory Environment for Science* (Washington, DC: GPO, 1985), Chapter 2.

Isaiah Bowman's Committee on Science and the Public Welfare recommended that a National Research Foundation be established, and that it encompass divisions of Natural Sciences, Medical Research, and National Defense. Using the OSRD as a model, the committee proposed that the Foundation be allowed to use contracts and grants as it saw fit and that the receiving institutions be reimbursed only for their direct costs. Moreover, the Foundation should be free to negotiate its grants and contracts with the best institutions without regard to geographical distribution formulas. Finally, the Foundation was to fund basic research and to coordinate the nation's science policy, such as it was.[19] To this latter point, Bush forcefully argued:

> We have no national policy for science. The Government has only begun to utilize science in the Nation's welfare. There is no body within the Government charged with formulating or executing a national science policy. There are no standing committees of the Congress devoted to this important subject. Science has been in the wings. It should be brought to the center of the stage—for in it lies much of our hope for the future.[20]

On the same day Bush's report was released, Senator Warren G. Magnuson (Democrat of Washington) introduced legislation to create a national research foundation. Drafted in consultation with Bush, Magnuson's legislation followed closely the ideas put forward in *Science—The Endless Frontier.* Senator Kilgore responded by introducing an alternative bill that reflected his own ideas for the Government support of science. Thus began a vigorous Congressional debate over the organization of postwar science policy.

The areas of disagreement between Kilgore and Bush not only divided the science policymakers during the immediate post-World War II era, delaying the establishment of the National Science Foundation until 1950, but they also remained fundamental points of contention throughout the next four decades. Although there were several minor points of dispute, four major issues dominated the debates: (1) the governing structure of the proposed national science foundation, (2) patent policy associated with publicly financed research, (3) Federal support of the social sciences, and (4) geographical distribution of Federal research funds.

Despite these points of disagreement, it was Vannevar Bush who established the terms of the debate through the publication of his report. In *Science—The Endless Frontier,* Bush simply made explicit the implicit arguments that had been presented by the National Resources Committee in its three-volume report, *Research—A National Resource* (1938–1941). Better than anything previously published, the Bush Report articulated and argued convincingly the rationale for the Government support of science. No other single document became so important to the postwar science policy debate. Although not always closely followed, it has remained the cornerstone for science policy in the United States.

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[19] See Bush, *Science—The Endless Frontier,* pp. 36–39. As proposed, the Foundation would have a broad scope and funding authority.

[20] *Ibid.*, p. 12.

# IV. THE POLITICS OF POSTWAR SCIENCE POLICY, 1945–1950

The five-year period after World War II was critical to the development of science policy in the United States. The mechanisms, rationales, and structures for the Federal support of science which were put into place during this period changed only slightly in the years thereafter. The atomic bombings of Hiroshima and Nagaski—along with the other science-related developments of World War II—not only heightened the public's interest in science and technology, but also convinced military planners of the need to continue the Armed Services' support of research and development.[1] Government policymakers concerned with the nation's shift from a wartime to a peacetime economy also saw the possibilities of applying the results of research to the civilian sectors of society.

Another major issue in the politics of postwar science policy was the creation of a central scientific agency. Although the National Science Foundation legislation was proposed in 1945, Congress did not pass a bill until 1947. President Truman's veto led to another round of debate. Although a National Science Foundation was finally created in 1950, the pattern of postwar Federal science support had already been established, largely through programs in the Office of Naval Research, the Atomic Energy Commission, and the National Institutes of Health, which had filled the void left by the disbandment of the OSRD after the war. Rather than developing a broad program of coordinated, basic research through the early establishment of a single agency, the nation's science structure developed in a pluralistic, mission-oriented manner.[2]

## The Continuing Debate Over NSF

By June 1945, both Vannevar Bush and Senator Harley Kilgore had recommended the creation of a central scientific agency. Their two positions shared much in common, yet their differences characterized the debate over the organization, function, and size of the proposed agency. This debate remained unresolved long after the formal establishment of the National Science Foundation in 1950.[3]

Legislation to create a national research foundation was first introduced by Senator Warren G. Magnuson in July 1945. The Magnuson bill was fully in accord with Bush's position. As noted, Sena-

[1] For an analysis of American attitudes toward science and science policy during the immediate postwar years, see Kenneth MacDonald Jones, "Science, Scientists, and Americans: Images of Science and the Formation of Federal Science Policy, 1945–1950," Ph.D. dissertation, Cornell University, 1975.

[2] For a concise overview of science policy during the Truman Administration, see John Walsh, "Truman Era: Formative Years for Federal Science," *Science,* 179 (January 1973), 262–265; and A. Hunter Dupree, "Paths to the Sixties," in David L. Arm (ed.), *Science in the Sixties* (Albuquerque: University of New Mexico Press, 1965), pp. 5–9.

[3] For a thorough description and analysis of the debates surrounding the formation of the NSF, see J. Merton England, *A Patron for Pure Science: The National Science Foundation's Formative Years, 1945–57* (Washington: National Science Foundation, 1982).



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tor Kilgore responded by introducing separate legislation later that month which incorporated his own ideas. The Magnuson and Kilgore science bills were debated in a series of joint hearings held in the fall of 1945.[4] These hearings provided an open forum for the debate and development of postwar science policy, and nearly all the leaders of science were given the opportunity to testify. A clear consensus was reached regarding the need for Government support for science and the desirability of establishing a science foundation. The areas of disagreement corresponded to the differences expressed earlier between Kilgore and Bush, namely the organization of the foundation, the distribution of funding, the role of social sciences, and patent policy.

The governing structure of the proposed National Science Foundation was a major point of contention. The Magnuson bill, based upon Bush's *Science—The Endless Frontier,* proposed a strong National Science Board made up of part-time people unconnected with the Government in any other manner. The Board would appoint the director, establish policy, and award grants and contracts. The Kilgore bill, on the other hand, proposed an organization with a strong director appointed by the President and a National Science Board that served only in an advisory capacity. Testifying before the Magnuson-Kilgore hearings, Bureau of the Budget director Harold Smith spoke in favor of the latter approach:

> I believe that the most important principle involved in these bills is that an agency which is to control the spending of government funds in a great national program must be a part of the regular machinery of government. If the government is to support scientific research, it should do so through its own responsible agency, not by delegating the control of the programs and turning over the funds to any non-governmental organization.[5]

Patent policy was another point of disagreement, and occupied the greatest amount of time at the hearings. The debate was over whether patents resulting from Government-supported research should be the property of the discoverer or the Government. Magnuson's bill proposed a patent policy similar to that followed by the OSRD during the war, in which private contractors received patents for work supported by Federal funds. Kilgore favored a patent policy that would prohibit individuals or corporations from taking out patents on discoveries arising from Government-supported research, making them instead available to the public through Government ownership.[6]

Bush and Kilgore also had serious disagreements over the geographical distribution of Federal research funds. Kilgore favored a wide distribution of funds. To prevent the bulk of Federal monies from going solely to colleges and universities in the East, Kilgore

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[4] U.S. Congress, Senate Committee on Military Affairs, *Hearings on Science Legislation,* hearings on S. Res. 107 and S. Res. 146 (79th Congress, 1st session. Washington: GPO, 1945). See also, James L. Penick, Jr., Carroll W. Pursell, Jr., Morgan B. Sherwood, and Donald C. Swain (eds.), *The Politics of American Science: 1939 to the Present* (Cambridge: The MIT Press, 1972), pp. 120-122; and National Academy of Sciences, *Federal Support of Basic Research in Institutions of Higher Learning* (Washington: National Research Council, 1964), pp. 32-33.

[5] Senate Committee on Military Affairs, *Hearings on Science Legislation,* p. 96.

[6] See England, *A Patron for Pure Science,* pp. 5-6 and 52-57.

argued for the adoption of a formula for state by state distribution. Bush, on the other hand, argued that the primary consideration in the award of Federal research funds should be excellence. Finally, the social sciences were an issue. Bush did not want them included, but Kilgore did.[7]

The science community found itself split between the two positions. Those supporting Bush included many prominent and influential leaders of the science community, often representing the nation's dominant universities and corporations.[8] Scientists favoring the Kilgore approach included the Federation of American Scientists, the Washington Association of Scientists, and the Association of Land-Grant Colleges and Universities.

Conservative members of Congress tended to support Bush, while liberal members generally sided with Kilgore. The Truman Administration was clearly on the side of Kilgore, and its position was most actively presented by the Bureau of the Budget.

## Science Policy Under President Truman

President Truman fully appreciated the need for Federal support of scientific research during peacetime. In his 21-point reconversion program presented to Congress as a special message on 6 September 1945, he asserted: "No nation can maintain a position of leadership in the world of today unless it develops to the full its scientific and technological resources. No government adequately meets its responsibilities unless it generously and intelligently supports and encourages the work of science in university, industry, and . . . its own laboratories."[9] To achieve this goal, Truman recommended that Congress adopt legislation to create a single Federal research agency that would promote and support research in defense, the natural and social sciences, and medicine and public health. Moreover, Truman argued that this agency should be charged with coordinating the scientific research activities undertaken in the various Federal agencies and departments.

### THE ATOMIC ENERGY COMMISSION

The creation of the Atomic Energy Commission (AEC) in 1946 essentially pared off atomic energy as an independent area of science policy.[10] The military use of atomic energy ensured that the devel-

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[7] For a discussion of the Federal Government's support of the social sciences, see Gene M. Lyons, *The Uneasy Partnership: Social Science and the Federal Government in the Twentieth Century* (New York: Russell Sage Foundation, 1969).

[8] See Penick, et al., *The Politics of American Science*, p. 121.

[9] Harry S. Truman, "Special Message to Congress Presenting a 21-Point Program for the Reconversion Period," 6 September 1945, *Public Papers of the Presidents of the United States, Harry S. Truman, 1946* (Washington: GPO, 1962), p. 293. Truman's science policy was "Point 12" in this message; pp. 292–294.

[10] For the background of the Atomic Energy Commission and a discussion of the development of nuclear energy in the United States, see Richard G. Hewlett and Oscar E. Anderson, Jr., *The New World, 1936–1946*, (University Park: Pennsylania State University Press, 1962); Richard G. Hewlett and Francis Duncan, *Atomic Shield, 1947–1952* (University Park: Pennsylvania State University Press, 1969); Corbin Allardice and Edward R. Trapnell, *The Atomic Energy Commission* (New York: Praeger, 1974); George T. Mazuzan and J. Samuel Walker, *Controlling the Atom: The Beginnings of Nuclear Regulation, 1946–1962* (Berkeley: University of California Press, 1985); and Richard G. Hewlett and Jack M. Holl, *Atoms for Peace and War, 1953–1960* (to be published).

opment of nuclear power would remain a policy issue separate from that of general science policy. Indeed, nothing did more to link science with national security in the American mind than the development of the atomic bomb. The AEC was intended to manage and regulate the development of nuclear energy in the United States, paying close attention to questions of national defense and national security, but putting it clearly under civilian control.

The debate over the control and development of atomic energy revolved around the issue of military versus civilian control. In addition, scientists like Niels Bohr, James Franck, and Leo Szilard led an effort in the scientific community to establish international control of atomic energy in order to avert an arms race. Several Congressional hearings were held on the development of domestic policy for atomic energy.[11] Important legislation that grappled with the debate over military and civilian control was introduced by Senator Edwin C. Johnson, Democrat of Colorado, and Representative Andrew Jackson May, Democrat of Kentucky. May and Johnson, who chaired the House and Senate military affairs committees respectively, proposed the creation of a board to oversee the nation's postwar atomic energy program. Their bill gave the military a central role in the future development of nuclear power.

Upon learning of the May-Johnson bill, many of the scientists who worked at the various laboratories associated with the Manhattan Project began to organize a protest. The Federation of American Scientists was founded to lobby for civilian control of the atomic energy program. Through public hearings, active lobbying, and other public activities, this group of scientists argued vigorously and successfully for the defeat of the bill. Moreover, the "Atomic Scientists' Movement," which developed soon after World War II, worked diligently to educate the public also about the danger of nuclear weapons and their proliferation.[12]

An alternative bill was presented by the chairman of the Senate Special Committee on Atomic Energy, Senator J. Brian McMahon, Democrat of Connecticut. The McMahon bill was similar to the May-Johnson bill with respect to the form of regulation to be developed. It differed, however, in its deemphasis of the military role in regulation and its promotion of civilian application of nuclear power. McMahon's bill won out, and on 1 August 1946 the Atomic Energy Act was signed into law by President Truman.

Taking its lead from the OSRD, the AEC undertook much of its research through contracts with universities, industry, and nonprofit organizations. In addition, it also created a system of national laboratories, many of them inherited from the Manhattan Project. These laboratories—which were Government-owned and contractor-operated—included Oak Ridge National Laboratory, Los Alamos Scientific Laboratory, Argonne National Laboratory, Lawrence Radiation Laboratory, Ames Laboratory, Bettis Plant, and

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[11] See, for example, U.S. Congress, Hearings before the Special Committee on Atomic Energy, *A Bill for the Development and Control of Atomic Energy* (79th Congress, 2nd session. Washington: GPO, 1947).

[12] See Alice K. Smith, *A Peril and a Hope: The Scientists' Movement in America, 1945–47* (Chicago: University of Chicago Press, 1965); and Arthur Steiner, "Scientists, Statesmen, and Politicians: The Compelling Influences on American Atomic Energy Policy, 1945–1946," *Minerva*, 12 (October 1974), 469–509.

Brookhaven National Laboratory. A small amount of research was undertaken for the AEC within the laboratories of other Federal agencies. The nuclear fission research undertaken by the Manhattan Project was subsumed by the AEC, and the Commission quickly became one of the leading Government scientific agencies. Its extensive program of research support and graduate fellowships focused primarily on the field of physics. In order to provide the AEC with scientific and technical advice, a General Advisory Committee (GAC) was established by statute and staffed with eminent scientific and technical leaders who had had extensive experience in the major wartime projects. Former Los Alamos Scientific Laboratory director J. Robert Oppenheimer was elected chairman of the GAC.

The Joint Committee on Atomic Energy was established concurrently with the AEC in 1946.[13] The committee consisted of eighteen members, nine from the Senate and nine from the House of Representatives. The chairmanship was to rotate between the House and Senate every two years. Several precedents existed for the creation of joint committees, such as those on taxation, printing, and the economic report; however, these earlier joint committees did not have legislative authority. This joint committee was, instead, established as the legislative committee for referral of all bills dealing with the AEC or atomic energy in general. It could introduce its own bills in either house. It also maintained investigative and informational responsibilities, which it pursued primarily through hearings. Finally, its policymaking role left it with the duty of making recommendations to Congress.

### THE NATIONAL INSTITUTES OF HEALTH

During World War II, the Committee on Medical Research within the OSRD coordinated the Government's sponsorship of medical research, and did so with great success. Perhaps the most important medical advance of this period was the development of penicillin. With the promise of future medical research high in many areas, Congress was anxious to further such work. The centralized national research foundation proposed by Vannevar Bush would have included biomedical research, as did the OSRD. Yet without such a foundation in place, coordination of research had to take place elsewhere. Seeing the opportunity at hand, the Public Health Service moved in, assuming these responsibilities within its research branch, the National Institute of Health (NIH).[14]

The NIH had been conducting medical research in its own laboratories since its founding in 1930. In 1945, it took over the research contracts that had been administered during the war by the OSRD's Committee on Medical Research. Although the NIH contin-

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[13] For an appraisal of the early years of the Joint Committee on Atomic Energy, see Morgan Thomas, *Atomic Energy and Congress* (Ann Arbor: University of Michigan Press, 1956); and Clinton P. Anderson and James T. Ramey, "Congress and Research: Experience in Atomic Research and Development," *Annals of the American Academy of Political and Social Science,* 327 (January 1960), 85–94.

[14] See Donald C. Swain, "The Rise of a Research Empire: NIH, 1930 to 1950," *Science,* 138 (December 14, 1962), 1233–1237; and Stephen P. Strickland, *Politics, Science, and Dread Disease: A Short History of United States Medical Research Policy* (Cambridge: Harvard University Press, 1972). The passage of the National Heart Act in June 1948 created the National Heart Institute and changed the name of the National Institute of Health to the National Institutes of Health.

ued to conduct much of its research in-house, it also added a large extramural research grant program that it adopted from the OSRD. This grant system provided research support primarily to the nation's medical schools. The support of medical research continued to be tremendously popular throughout the postwar era, and Congressional appropriations for the NIH grew accordingly—from under $3 million in 1945 to over $52 million in 1950.[15]

### Veto of 1947 NSF Legislation

After two years of heated debate, Congress passed a National Science Foundation bill in 1947. The bill essentially followed Bush's position. But despite President Truman's support for the creation of a National Science Foundation, he vetoed the legislation on 6 August 1947 because of serious disagreements with several aspects of the bill. Truman's principal concern was the organizational issue. He feared the proposed legislation would place NSF in the hands of private citizens unaccountable to the Federal Government, thus producing an absence of administrative accountability. Truman insisted that the director and the 24 members of the National Science Board be appointed by the President.

In announcing his veto, Truman remarked:

> Our national security and welfare require that we give direct support to basic scientific research and take steps to increase the number of trained scientists. I had hoped earnestly that the Congress would enact a bill to establish a suitable agency to stimulate and correlate the activities of the Government directed toward these ends.
>
> However, this bill contains provisions which represent such a marked departure from sound principles for the administration of public affairs that I cannot give it my approval. It would, in effect, vest the determination of vital national policies, the expenditure of large public funds, and the administration of important governmental functions in a group of individuals who would be essentially private citizens. The proposed National Science Foundation would be divorced from control by the people to an extent that implies a distinct lack of faith in democratic processes.[16]

The veto resulted in a three-year delay in the passage of the NSF legislation. This delay permitted the subsidy of basic research to be assumed by the military (primarily through the Office of Naval Research), the National Institutes of Health, and the Atomic Energy Commission.

### The Steelman Report

Although the terms of the postwar science policy debate were effectively established by Vannevar Bush's 1945 report, *Science—The*

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[15] See Rufus E. Miles, Jr., *The Department of Health, Education, and Welfare* (New York: Praeger Publishers, 1974), pp. 189–190.

[16] "Memorandum of Disapproval of the National Science Foundation Bill," *Public Papers of the Presidents of the United States: Harry S. Truman, 1947* (Washington: GPO, 1963), pp. 368–369.

*Endless Frontier,* their premises did not go unchallenged. The Truman Administration found several aspects of that report objectionable, and countered by establishing a temporary President's Scientific Research Board in October 1946.[17] Headed by Truman assistant John R. Steelman, the Board's sole purpose was to prepare a report to the President which addressed the status of American science and made recommendations concerning Federal research programs. The report was intended to counter the elements of the Bush Report which members of the Truman Administration opposed, therefore proposing a science policy more consistent with the New Deal political philosophy. The "Steelman Report"—entitled *Science and Public Policy*—was released in 1947.[18]

There was no discrepancy between the findings of the Steelman and Bush reports with regard to the overall value assigned to scientific research. Both reports argued that scientific research ultimately led to broad benefits in the areas of economic growth, improved health, and strengthened military security. In Steelman's words:

> The security and prosperity of the United States depend today, as never before, upon the rapid extension of scientific knowledge. So important, in fact, has this extension become to our country that it may reasonably be said to be a major factor in national survival.[19]

Like the Bush Report, the Steelman Report recommended continuing growth in the Federal support of science, likening such support to an investment in the overall health and advancement of the nation. The Steelman Report also stressed the need to train future generations of scientists, a point emphasized by Bush and others during the immediate postwar period. Finally, the reports agreed on the fundamental need for a "unified policy for science"—something, Steelman argued, that "the United States has yet to develop."[20]

The most important difference between the two reports involved the Federal research establishment. Bush essentially omitted it in his report, while Steelman—in accord with the Truman Administration—gave it great emphasis. *Science—The Endless Frontier* was concerned almost exclusively with the research needs outside the Federal Government. *Science and Public Policy,* on the other hand, addressed these needs as well as those of the researchers working within the Federal departments and agencies.

The second major difference was the length and depth of coverage offered by the two reports. Faced with a pressing deadline at the end of the war, Bush chose to produce a short, hard-hitting,

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[17] See Executive Order No. 9791, October 17, 1946. Board members consisted of the Secretaries of Agriculture, Commerce, Interior, War, and Navy, the Chairmen of the Atomic Energy Commission, Federal Communications Commission, National Advisory Committee for Aeronautics, and Tennessee Valley Authority, the Administrators of Federal Loan, Federal Works, Federal Security, and Veterans Affairs, and the Director of the Office of Scientific Research and Development.

[18] John R. Steelman, *Science and Public Policy: A Report to the President,* 5 volumes (Washington: GPO, 1947). The subtitles are as follow: volume one, *A Program for the Nation;* volume two, *The Federal Research Program;* volume three, *Administration for Research;* volume four, *Manpower for Research;* and volume five, *The Nation's Medical Research.*

[19] Steelman, *Science and Public Policy,* vol. I., p. 3.

[20] *Ibid.,* vol. III, p. 9.

and popular document. Steelman's five-volume report examined the nation's science policy in a meticulous, integrated, and comprehensive manner—a task that has since been unrepeated in its scope, save perhaps by the 1964 studies produced by the House Select ("Elliott") Committee on Government Research.[21] As a result of this difference, the Steelman Report offered far more specific recommendations than did the Bush Report. For example, in its call for a high and sustained level of funding for research and development, the Steelman Report recommended the establishment of a minimum spending level equal to one percent of the gross national product.

Many of the differences between the Steelman and Bush reports mirrored the differences between Kilgore and Bush, with the Steelman Report coinciding with the positions previously taken by Senator Kilgore. The debate was over *how* the Government should support science, not *whether* it should provide such support. The specific areas of disagreement included: the ownership of patents resulting from Government-sponsored research, geographical distribution of research funds, the inclusion of the social sciences, and political control of the National Science Foundation.

The Steelman Report made several recommendations that would bring science policymaking back into the White House—a situation that briefly existed during the Great Depression, and that flourished during World War II with the OSRD. The elimination of the OSRD meant that coordination of Federal research and development passed from the White House to the various agencies. The only remaining mechanism of control by the President was the Bureau of the Budget, but this was restricted to fiscal matters. Steelman recommended that an Interdepartmental Committee on Scientific Research and Development be created, and that a White House science adviser be appointed.[22] President Truman followed the first recommendation, creating the Interdepartmental Committee in 1947 composed of bureau chiefs responsible for scientific research and development. Truman did not, however, establish the post of Presidential science adviser. Instead, the National Science Foundation was assigned the role of coordinating research and advising the President.[23] Moreover, the President was also given access to the Science Advisory Committee established within the Office of Defense Mobilization in 1951.[24]

## Military Support of Basic Research

President Truman terminated the OSRD on 26 December 1947.[25] Anticipating its disappearance, the Secretaries of War and Navy established the Joint Research and Development Board in June 1946. The Board was composed of two representatives from each

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[21] See U.S. Congress, Select Committee on Government Research of the House of Representatives, *Federal Research and Development Programs* (88th Congress, 2nd session. Washington: GPO, 1964).

[22] See Steelman, *Science and Public Policy*, vol. I, p.65

[23] See J. Stefan Dupré and Sanford A. Lakoff, *Science and the Nation: Policy and Politics* (Englewood Cliffs, N.J.: Prentice-Hall, 1962), pp. 65–67.

[24] See Detlev W. Bronk, "Science Advice in the White House: The Genesis of the President's Science Advisers and the National Science Foundation," *Science*, 186 (October 11, 1974), 116–121.

[25] Executive Order No. 9913, 26 December 1947.

branch of the Armed Forces and a civilian chairman.[26] Vannevar Bush was made the Board's first chairman, and he reported directly to both Secretaries. The purpose of the Board was to establish a military research and development program, one which coordinated such activities in the interest of both departments. Moreover, it sought to continue the military's close relationship with civilian scientists and universities.[27]

The Navy in particular was anxious to reorganize its scientific research and development efforts after the war and to establish its ties with the nation's research universities. In so doing, it established the temporary Office of Research and Inventions in May 1945. The Navy gained Congressional approval for a permanent research operation in August 1946 with the creation by statute of the Office of Naval Research (ONR).[28] A regular Navy officer was made director of ONR, while a civilian chief scientist served as deputy director and administered the various programs. A Naval Research Advisory Committee was also established in 1946 and, along with numerous other special committees and panels, it brought eminent civilian scientists to the service of the Navy as advisors on projects and screeners of research proposals—thus providing an early and successful peer review system.

Although ONR's main purpose was to support scientific research related to the Navy's defense mission, it was also charged with sponsoring and promoting a broad array of basic research. Indeed, many of its early research projects had little apparent bearing on defense issues. The ONR was quick to establish good relations with the nation's universities, and the scientific community came to view its program as a great success. Its research support was carried out largely through contracts with universities—a continuation of the principal method used by the OSRD—and its contracts were awarded on the basis of scientific merit. Its support of research was both generous and relatively free of administrative or programmatic restrictions, thus helping to ensure academic freedom.[29]

The ONR played a major role in the support of basic research in the United States, especially during the years before the formal establishment of the NSF. Moreover, the ONR was so highly regarded that many of its management practices and policies later served as a model for the National Science Foundation. It also served as a training ground for many of NSF's top administrators. For example, ONR's first chief scientist, Alan T. Waterman, became the first director of NSF.

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[26] Generals Carl Spaatz and J.L. Devers represented the Army, while the Navy was represented by Admiral D.C. Ramsey and Assistant Secretary of the Navy W. John Kenney.

[27] See Daniel J. Kevles, "Scientists, the Military, and the Control of Postwar Defense Research: The Case of the Research Board for National Security, 1944–46," *Technology and Culture*, 16 (January 1975), 20–47.

[28] Public Law No. 588. For general commentary, see Arthur D. Little, Inc., *Basic Research in the Navy: A Report to the Naval Research Advisory Committee*, 2 volumes (Cambridge, Mass.: n.p., 1959); F. Joachim Weyl (ed.), *Research in the Service of National Purpose: Proceedings of the Office of Naval Research Vicennial Convocation* (Washington: GPO, 1966); and National Academy of Sciences, *Federal Support of Basic Research*, pp. 36–39.

[29] For an excellent overview of the Navy's entire research program after the war, see David K. Allison, "U.S. Navy Research and Development since World War II," in Merritt Roe Smith (ed.), *Military Enterprise and Technological Change: Perspectives on the American Experience* (Cambridge: The MIT Press, 1985), pp. 289–328.

Outside the Navy, other Department of Defense programs were later established to support basic research, including the Army Research Office (ARO) established in 1951 and the Air Force Office of Scientific Research (AFOSR) founded in 1952.[30] This essentially amounted to an institutionalization of the wartime cooperation between scientists and the military. The services maintained their link with civilian scientists. With each of the armed services sporting its own scientific office, Vannevar Bush's call for a civilian national research foundation with jurisdiction over defense-related research was effectively superseded. Military research would be conducted in, and supported by, the military itself.

## Summary

Several polarizing issues fueled the science policy debate between 1945 and 1950, delaying for that entire period the creation of a National Science Foundation. As a result, the pattern for the Federal support of science was firmly established during those five years, most of it filling the void left by the dismantled OSRD. This delay ultimately meant a weakened NSF—at least the NSF envisioned by Vannevar Bush, with strong components of military and medical research—and also assured the pluralistic, loosely coordinated nature of the nation's science effort.

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[30] For a general account of the military support of research after World War II, see the relevant chapters in Smith, *Military Enterprise and Technological Change*; and Harvey M. Sapolsky, "Academic Science and the Military: The Years since the Second World War," in Nathan Reingold (ed.), *The Sciences in the American Context: New Perspectives* (Washington: Smithsonian Institution Press, 1979), pp. 379–399. For the Air Force in particular, see Thomas A. Sturm, *The USAF Scientific Advisory Board: Its First Twenty Years, 1944–1964* (Washington: GPO, 1967); and William J. Price, et al., "Science-Technology Coupling: The Experience of the Air Force Office of Scientific Research," in William H. Gruber and Donald G. Marquis (eds.), *Factors in the Transfer of Technology* (Cambridge. The MIT Press, 1969), pp. 117–136.

# V. THE NATIONAL SCIENCE FOUNDATION AND THE SOLIDIFICATION OF AMERICAN SCIENCE POLICY, 1950–1957

After five years of debate, Congress and the President settled on a plan to establish the National Science Foundation. Yet the organization created in 1950 was not the same one envisioned by its early proponents; it was not a centralized agency in charge of coordinating the Federal Government's scientific research programs in the areas of medicine, atomic energy, military, and basic research. The wartime Office of Scientific Research and Development had maintained significant coordinating authority, but with its break-up and the subsequent delay in creating the NSF, other agencies stepped in to assume responsibility for the various sectors of the nation's overall science policy. By 1950, a pluralistic system of science support was firmly entrenched, including the scientific research and development programs within the Atomic Energy Commission, in the National Institutes of Health, and in each of the armed services. And so, during the period 1950–57, the NSF remained a relatively small organization responsible for basic research, while the other agencies carrying out scientific research and development continued to develop and expand their programs.

## Creation of the National Science Foundation

Lacking the broad base of Vannevar Bush's proposed National Research Foundation—which would have included basic research in the medical and military arenas—the National Science Foundation established by Congress was a modest agency with the more limited responsibility of supporting basic research primarily within universities. The 1950 NSF legislation signed by President Truman represented a pragmatic compromise between the Democratic Administration and the followers of the Bush approach, a compromise that left neither side completely satisfied.[1]

The political accountability of the NSF director and the National Science Board had been one of the most heated areas of controversy. It was, in fact, President Truman's principal reason for vetoing the 1947 NSF legislation. He wanted the NSF under civilian political control. In the 1950 legislation, the NSF director and the 24 members of the National Science Board were all to be appointed by the President with the advice and consent of the Senate. This arrangement, which was acceptable to the Truman Administration,

[1] The best history of the creation and early development of the National Science Foundation is J. Merton England, *A Patron for Pure Science: The National Science Foundation's Formative Years, 1945–57* (Washington: National Science Foundation, 1982). Also useful are Dorothy Schaffter, *The National Science Foundation* (New York: Frederick A. Praeger, 1969); and Milton Lomask, *A Minor Miracle: An Informal History of the National Science Foundation* (Washington: National Science Foundation, 1976).

thus gave the NSF far less autonomy than the agency would have received under the vetoed 1947 legislation.

The NSF was given broad authority to fund basic research within the fields of the physical, mathematical, engineering, biological, and medical sciences. As recommended by Vannevar Bush, the social sciences were not listed as a specific field to receive support. Instead, the social sciences were only eligible for funding under the category of "other sciences." Although some of the social sciences received modest funding under this arrangement before 1958, it was decided in that year to expand formal support by establishing an Office of Social Science within the NSF. However, it was not until 1968 that Congress specifically directed the NSF to sponsor research in the social sciences.[2]

Although the NSF was instructed to avoid "undue concentration" in its award of research funds, it rejected proposals to establish a formal program or formula for the actual promotion of geographical distribution of research funds. The National Association of State Universities and Land Grant Colleges was the most persistent advocate of instituting a formula method for distributing some of the NSF funds, but its position was not widely supported by members of the scientific community and Congress. Instead, Congress decided that merit would be the ruling factor in awarding research grants and fellowships. This, of course, was the approach favored by Vannevar Bush.[3]

As it became clear during subsequent Congressional hearings that the NSF would focus strictly on basic research, a consensus was reached that patent laws should not be addressed in the NSF legislation. Thus, patent policy faded as an issue for the NSF, despite the fact that Congressional leaders continued to argue over whether patents resulting from publicly-financed research should become the property of the Government or of the individuals or corporations who made the discovery. Nevertheless, patents were not prohibited under the 1950 NSF legislation.[4]

The 1950 legislation represented a compromise on all of the major disputes associated with the creation of the National Science Foundation, but it did not put an end to these disagreements. The debates of this era continued to define the divisions within science policymaking throughout the next 40 years. In its report on the development of Federal research policy, the National Academy of Sciences observed:

> If one proposition is fundamental to the whole postwar debate regarding the structure of science and its link to the government, it is that few—either in Congress or in the scientific community—wished a czar of science. The Act of 1950, by its construction of the National Science Board and the Division Committees, expressed the judgment of Congress that the system of advisory scientific

[2] See John T. Wilson, *Academic Science, Higher Education, and the Federal Government: 1950–1983* (Chicago: University of Chicago Press, 1983), pp. 9–10; and England, *A Patron for Pure Science*, pp. 266–273.

[3] See England, *A Patron for Pure Science*, passim.

[4] For the Congressional debates over the establishment of the NSF, see England, *A Patron for Pure Science*, pp. 83–106.

panels was a legal and necessary part of the government's machinery.[5]

This preference for a pluralistic structure of Federal science support was reflected in the NSF's failure to absorb the military, nuclear, and medical research programs developed within the Department of Defense, Atomic Energy Commission, and National Institutes of Health. Despite some early proposals for the NSF to include such research, the framework for the Federal support of science already had been established. Proponents of a central scientific organization continued to tout the virtues of coordination and planning. Nevertheless, Congress chose to maintain the traditional pluralistic system of Federal support for science.

As a result, NSF's funding levels for scientific research remained far lower than those of the mission-oriented agencies. Although Bush had called for a budget of $33.5 million for NSF's first year, its initial budget was $3.5 million. By its fifth year, NSF had a $16 million budget, rather than Bush's target of $122.5 million. The agency's budget amounted to only a small percentage of the nation's overall expenditures for research and development. Federal support of basic research thus remained overwhelmingly the product of the mission agencies.

## NSF's Science Policy Responsibilities

By 1950, the Bureau of the Budget (BOB) had become dissatisfied with what it saw as the fragmented, uncoordinated character of the Federal science program. Within the Executive Branch, the BOB historically had been the principal office responsible for overseeing the various Federal programs, and did so through its evaluation of annual requests for appropriations. The rapid expansion of research and development programs throughout the Federal Government since World War II placed a special burden on the BOB.[6] In consequence, it sought to infuse the NSF with national science policymaking responsibilities, especially with regard to the scientific research programs of the various Federal agencies. This informal pressure to strengthen the NSF's science policymaking function during the early 1950s received official sanction in 1954 when President Eisenhower issued an Executive Order specifically assigning policymaking responsibilities to the NSF.[7] The NSF never lived up to these science policymaking expectations, partly because its position within the Government hierarchy did not grant it authority over other agencies and departments. Fearing political repercussions from the other agencies with science programs, NSF Director Alan Waterman also made the decision to limit NSF's science policy authority.[8]

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[5] National Academy of Sciences, *Federal Support of Basic Research in Institutions of Higher Learning* (Washington: National Research Council, 1964), p. 47.

[6] See William D. Carey, "Budgeting for Science: Presidential Responsibility," *Annals of the American Academy of Political and Social Science,* 327 (January 1960), 76–84; and Morgan Sherwood, "Federal Policy for Basic Research: Presidential Staff and the National Science Foundation, 1950–1956," *Journal of American History,* 55 (December 1968), 599–615.

[7] Executive Order No. 10521, 17 March 1954. See also, Wilson, *Academic Science,* pp. 24–25.

[8] See England, *A Patron for Pure Science,* pp. 181–202.

## Impact of the Cold War and Korean War on Science Policy

National security was a major driving force behind U.S. science policy in the late 1940s and 1950s, fueled in large measure by the Cold War and the Korean War. The arms race, which was greatly accelerated after 1949 when the United States lost its atomic monopoly, became an important element in both the Cold War and science policy. Later in the decade, the space race came to wield a similarly large influence. Military strength and national prestige became key elements in the rationale for Government support of science. Military agencies funded about 70 percent of the total Federal expenditures for research and development during the early 1950s, thus minimizing the overall impact of the NSF. National security remained the principal rationale for the support of basic research throughout this period, even for the NSF.

One response to America's involvement in the Korean War was the establishment of the Science Advisory Committee (SAC) within the Office of Defense Mobilization in 1951. It was an attempt to provide the White House with overall civilian scientific advice on mobilization planning, something that had been lost with the break-up of the OSRD.[9]

An unsavory side effect of the Cold War was the new Red Scare, or "McCarthyism." Working through the Senate Committee on Government Operations, Republican Senator Joseph R. McCarthy of Wisconsin held a series of hearings during the early 1950s in which the loyalty of scientists working in government laboratories was challenged. The loyalty of a number of scientists applying for research grant support from the National Institutes of Health was also questioned. Unfortunately, these hearings were sometimes characterized by wild accusations brought against innocent people, and as a result served to create a good deal of mistrust within the scientific community toward the investigatory powers of Congress.

Few things did more to estrange American scientists from their government than the celebrated and inflammatory loyalty-security case involving J. Robert Oppenheimer. As director of the Los Alamos Scientific Laboratory during World War II, Oppenheimer led the highly successful effort to create the atomic bomb. After the war, Oppenheimer returned to his academic career as a professor of theoretical physics. The popular and influential Oppenheimer, widely regarded as one of the leading spokesmen among American scientists, also served as a consultant with the Department of Defense, State Department, and the White House. After the creation of the Atomic Energy Commission in 1946, he was elected chairman of the AEC's principal scientific advisory committee, the General Advisory Committee. As its chairman, he worked to reduce the nation's reliance upon massive retaliation, advocating the development of small tactical nuclear weapons while opposing the crash development of the hydrogen bomb.[10]

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[9] See Detlev W. Bronk, "Science Advice in the White House: The Genesis of the President's Science Advisers and the National Science Foundation," *Science*, 186 (October 11, 1974), 116–121.

[10] For material on the Oppenheimer case, see Walter Gellhorn, *Security, Loyalty, and Science* (Ithaca: Cornell University Press, 1950); U.S. Atomic Energy Commission, *In the Matter of J. Robert Oppenheimer: Transcript of Hearing before Personnel Security Board* (Washington: GPO,

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Oppenheimer's opposition to the hydrogen bomb project led to professional and personal opposition to him within the Department of Defense and elsewhere, including from the formidable AEC Commission chairman, Lewis Strauss. On 7 November 1953, the former executive director of Congress's Joint Committee on Atomic Energy, William L. Borden, addressed a letter to FBI director J. Edgar Hoover accusing Oppenheimer of being an agent of the Soviet Union. Wanting to avoid another investigative spectacle by Senator McCarthy, members of the Eisenhower Administration urged the AEC to conduct its own internal review of the Oppenheimer case. The agency, with the full support of Strauss, complied. Beginning in mid-April 1954, Oppenheimer was made the subject of four weeks of formal hearings within the AEC to determine if he was a security risk. Despite the highly questionable nature of the evidence and arguments, much of it loaded with innunendo and farfetched inference, the fears fed by McCarthyism led to the 27 May decision that Oppenheimer was loyal but should nevertheless be considered to be a security risk. As a result of this judgment, Oppenheimer was stripped of his security clearances and his various government connections were terminated—all of which seriously limited his ability to make future recommendations on science policy. The ruling, which gained nationwide press coverage, was held by many to be unjust. Nowhere was this more true than within the scientific community.

Reflecting the scientists' concern over their government's obsession with security, the National Science Foundation decided against instituting security checks for its prospective grantees, in part because the Foundation supported only unclassified research. The awards of research grants remained based on the investigator's competence and the merit of the research topic. The National Science Board adopted this policy in 1954 with the limiting condition that the NSF "would not knowingly support the research of an avowed Communist or an individual who had been determined to be a Communist by judicial proceedings or by an unappealed determination of the attorney general or the Subversive Activities Control Board, or of an individual who advocated change in the form of government by other than constitutional means." [11] Also excluded from NSF support were convicted saboteurs. Both the American Association for the Advancement of Science and the National Academy of Sciences supported this policy, and President Eisenhower made it government-wide in 1956.[12]

## Summary

Between 1950 and 1957, the various components that comprised the Federal system for the support of science were solidified. This system—the basis of which had been laid in the five years after World War II—was highly pluralistic in its make-up. Defense-relat-

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1954); Joseph Alsop and Stewart Alsop, *We Accuse! The Story of the Miscarriage of American Justice in the Case of J. Robert Oppenheimer* (New York: Simon and Schuster, 1954); Philip M. Stern, *The Oppenheimer Case: Security and Trial* (New York: Harper and Row, 1969); Herbert F. York, *The Advisors: Oppenheimer, Teller, and the Superbomb* (San Francisco: W. H. Freeman, 1976); and Barton J. Bernstein, "The Oppenheimer Conspiracy," *Discover*, 6 (March 1985), 22–32.

[11] Wilson, *Academic Science*, p. 27.

[12] *Ibid.*

ed research was both contracted to civilian scientists working outside the military and conducted within the armed services' own science offices. Medical and health-related research was in the purview of the National Institutes of Health, while nuclear research was carried out by the Atomic Energy Commission. Smaller mission-oriented research projects were undertaken by various other agencies and departments. The National Science Foundation, originally conceived as a central coordinating body, was left with a restricted jurisdiction over unclassified, basic research. In describing the workings of this system, A. Hunter Dupree said: "A plural set of government agencies went to a plural set of Congressional committees to ask for appropriations, which were then distributed by grant and contract to investigators in a plural set of universities."[13] It was this system that faced the demands for drastic expansion that followed in the wake of the Soviet technological breakthrough embodied in the *Sputnik* earth satellite.

[13] A. Hunter Dupree, "Science and Technology Policy since World War II," unpublished paper presented at Southern Oregon State College, 24 February 1983.

## VI. SPUTNIK AND ITS AFTERMATH, 1957–1965

### The Impact of Sputnik

The Soviet Union's successful launching of *Sputnik* on 4 October 1957 drew political attention to the relations between science and government. Occurring during the height of the Cold War, the orbiting of the world's first artificial earth satellite by the Soviets sparked a dramatic reappraisal of U.S. policy on scientific research and science education. People previously uninterested in the Government's science policy suddenly discovered its importance to international relations. Even though political and economic competition between the United States and the Soviet Union had been sharp throughout the Cold War, *Sputnik* served to highlight new challenges in scientific and technological areas.[1]

*Sputnik* did not, of course, alter the fundamental structure of Federal science support, nor did the event turn Federal policy in a radically different direction. The United States remained committed to its pluralistic, interrelated system of science support. *Sputnik* did, however, prompt a reexamination of the health of U.S. science and engineering. And it probably increased science's popularity or, at least, emphasized its importance to national welfare. Although *Sputnik*'s overall impact was largely the acceleration of trends already in place, it did help to make it politically easier to appropriate more money for research and development. As a result, the ten years following the launch of *Sputnik* constituted one of the periods of most rapid growth in the Federal support of science. These years also saw the development of a number of new science advisory mechanisms within the Federal Government.

The military threat and implications of *Sputnik* were clear and, in the context of the Cold War, ominous. For the ability of the Soviet Union to build rockets capable of propelling satellites into orbit also meant the ability to deliver hydrogen bombs atop intercontinental ballistic missiles. Even though American scientists and engineers had been aware of the Soviet space research and development program, they were surprised by the accuracy of a guidance system that could place satellites into a useful orbit. The feasibility of applying such a guidance system to the targeting of nuclear warheads was not missed by American military planners and scientific advisers.

*Sputnik* also did much to generate broad public interest in the Government's policy for civilian science and technology, even among politicians and social commentators who had rarely addressed such issues. Bernard Baruch, for example, wrote in the

[1] Walter A. McDougall's . . . *The Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1985) provides a detailed account of the impact of *Sputnik*, as well as of the overall development of the United States space program.

*New York Herald Tribune:* "America is worried. It should be, we have been set back severely, not only in matters of defense and security, but in the context for the support and confidence of the peoples throughout the world." [2] And rocketry specialist Wernher von Braun commented that *Sputnik* "triggered a period of self-appraisal rarely equaled in modern times. Overnight, it became popular to question the bulwarks of our society; our public educational system, our industrial strength, international policy, defense strategy and forces, the capability of our science and technology. Even the moral fiber of our people came under searching examination."[3] Mass media attention to *Sputnik* helped to create a political atmosphere in the United States that seemed to demand a reexamination of the Government's science policy. What went wrong, the commentators asked. How had the United States "lost" its technological advantage? Such questioning naturally began to focus attention also on the state of the nation's science education, from elementary school through postgraduate training.

### Congressional Response to Sputnik

Prompted by the widespread outcry over the news of *Sputnik,* Congressional leaders were quick to react. The Eisenhower Administration became a target of criticism in both houses of Congress, as Senators and Representatives alike spoke of the loss of U.S. international prestige and national security that resulted from the Soviet accomplishment. But these early criticisms hurled at the President did not stop the Congress from working with the Administration in drafting and passing several important pieces of legislation in 1958, including the National Aeronautics and Space Act, the Defense Reorganization Act, and the National Defense Education Act.

The orbiting of *Sputnik* inaugurated the beginning of the space race between the United States and the Soviet Union, a "race" that had significant effects on the character of American science policy. No other post-*Sputnik* law had a greater impact on increasing the Federal funding of scientific research and development than the National Aeronautics and Space Act. Signed into law by President Eisenhower on 29 July 1958,[4] this Act created the National Aeronautics and Space Administration (NASA) and ensured that the U.S. space program would be a civilian, rather than a military effort. In absorbing the old National Advisory Committee for Aeronautics, NASA became responsible for providing unique opportunities for scientific observation and experiment, as well as for the general technological advancement of the space program. Whereas NACA had performed most of its research inhouse, NASA became a major external contracting agency, thus giving a tremendous boost to the extramural research support offered by the Federal Government.[5]

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[2] Quoted in Robert D. Lapidus, "Sputnik and Its Repercussions: A Historical Catalyst," *Aerospace Historian,* 17 (Summer-Fall 1970), 89.
[3] Quoted in *Ibid.*
[4] Public Law 85–568.
[5] See McDougall, . . . *The Heavens and the Earth;* Homer E. Newell, *Beyond the Atmosphere: Early Years of Space Science* (Washington: National Aeronautics and Space Administration, 1980); and Alex Roland, *Model Research: The National Advisory Committee for Aeronautics, 1915–1958* (Washington: National Aeronautics and Space Administration, 1985).

### SPACE COMMITTEES ESTABLISHED

In correspondence with the creation of NASA, Congress realigned itself by forming new committees in the House and Senate to deal with space and science issues. This was a natural development, as Congressional committees traditionally paralleled the jurisdictions of the executive agencies with which they dealt. The creation of the Joint Committee on Atomic Energy in 1946, for example, paralleled the establishment of the Atomic Energy Commission in the same year. The formation of NASA called for a similar response. The Special Committee on Space and Astronautics was a temporary committee created by the Senate on 6 February 1958. Senator Lyndon B. Johnson, Democrat of Texas, was made chairman. The House also created a temporary committee: the Select Committee on Astronautics and Space Exploration established on 5 March 1958, with Massachusetts Democrat John W. McCormack appointed chairman.

Although efforts to establish a Joint Committee on Aeronautics and Outer Space were not successful, permanent standing committees were created in both houses to deal with space. On 21 July 1958, the House created the Committee on Science and Astronautics,[6] while the Senate established the Committee on Aeronautical and Space Science on 24 July 1958. The Senate committee limited its jurisdiction to NASA and issues relating to aeronautics and space. The House committee's jurisdiction, on the other hand, extended over both the space program and the nation's general science policy, including oversight of the National Science Foundation.

This Congressional reorganization had important ramifications for the formation of Federal science policy. Prior to *Sputnik,* Congress lacked the organization necessary to review the Government's overall research program. It was divided into committees (and the Appropriations Committees divided into subcommittees) which paralleled the jurisdictional divisions among the various executive agencies. As a result, Congress did not have a focal point where it could provide a unified, systematic approach to solving the nation's scientific research problems or setting a national science policy. Moreover, Congress lacked a professional staff with the technical and scientific training necessary to deal fully with these issues. The creation of the new space committees—especially the more broadly-defined House committee—was therefore an important step in providing Congress with the ability to assess fully the nation's overall research program.

### NATIONAL DEFENSE EDUCATION ACT

Congressional concern with the strength of the nation's system of education—especially in the sciences and mathematics—remained high throughout the years immediately following the launch of *Sputnik.* The National Defense Education Act of 1958 was a major attempt to bolster American education at all levels. Because of its

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[6] Changed to House Committee on Science and Technology in 1975. For a detailed history of the Committee, see Ken Hechler, *Toward the Endless Frontier: History of the Committee on Science and Technology, 1959–79* (Washington: GPO, 1980).

impact on science education, the Act quickly became a significant part of the nation's overall science policy. It provided for a student loan program, aid to secondary and elementary school instruction in science, mathematics, and foreign languages, National Defense fellowships for graduate students, and funds for improved counseling in high schools and colleges.[7]

### DEPARTMENT OF SCIENCE AND TECHNOLOGY PROPOSED

The *Sputnik* "threat" also played a role in Congressional initiation of much broader reorganization of science within the executive branch. For example, Democratic Senator Hubert H. Humphrey of Minnesota proposed establishing a Department of Science and Technology and a corresponding cabinet post of Secretary of Science and Technology. Humphrey, who was Chairman of the Subcommittee on Reorganization and International Organizations of the Committee on Government Operations, submitted this plan as part of the proposed Science and Technology Act of 1958. A number of hearings were held on the issue, and during the following year Humphrey submitted revised legislation to create a Department of Science and Technology.[8]

As proposed by Senator Humphrey, the new Department of Science and Technology would encompass the entire National Science Foundation, the Atomic Energy Commission, the National Aeronautics and Space Administration, and the National Bureau of Standards, along with the scientific research functions of the Smithsonian Institution. An alternative proposal recommended the creation of a Department of Science and Technology consisting of only the NSF and AEC.[9] In his testimony before Humphrey's Subcommittee, science historian A. Hunter Dupree supported the idea of establishing a "central policy agency," but criticized the structure of the proposed Department. His concern was that a Department made up of the various agencies would tend to administer the science programs themselves rather than set overall policy for science. The need for developing a science policy at the highest level of Government was great, he argued, as "the shape of a science policy cannot safely be left to the blind clash of competing agencies both in and out of the Government." [10]

In speaking in favor of the creation of a Department of Science, chemist and American Association for the Advancement of Science president Wallace R. Brode addressed the problems confronting the development of a sound national science policy in his 1959 AAAS presidential address:

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[7] Public Law 85-864. See also, Arthur S. Flemming, "The Philosophy and Objectives of the National Defense Education Act," *Annals of the American Academy of Political and Social Science,* 327 (January 1960), 132-138.

[8] U.S. Congress, Senate Committee on Government Operations, *Create a Department of Science and Technology,* hearings before the Subcommittee on Reorganization and International Organizations (86th Congress, 1st session. Washington: GPO, 1959), p. 1. See also, Hubert H. Humphrey, "The Need for a Department of Science," *Annals of the American Academy of Political and Social Science,* 327 (January 1960), 27-35. The history of this idea is presented in Carroll W. Pursell, Jr., "The Search for a Department of Science: An Historical Overview," unpublished paper written for the National Science Foundation, January 1985.

[9] See Senate Committee on Government Operations, *Create a Department of Science and Technology,* pp. 2-7.

[10] Ibid., p. 87.

> One of the most difficult tasks facing us is to achieve a long-range planning effort which would remove expediency as the sole controlling factor. A national science policy is needed for a wise and rational distribution of scientific activities, so that space, defense, education, atomic energy, oceanography, and medical research are not bidding against each other for limited available support. The growing demand for scientists in the face of a limited supply of scientists, materials, funds, and facilities requires major policy decisions as to the distribution of resources. These decisions should of course include the extent to which specialized agencies may recruit by scholarship, fellowship, and research support.[11]

Despite considerable support for the creation of a Department of Science and Technology, the legislation was never passed. It was opposed by several influential groups, both within Congress and the scientific community. Opponents included (a) scientists who preferred the pluralistic approach to Federal support of science; (b) agency officials concerned with protecting their areas of jurisdiction with regard to mission-oriented research support; and (c) individuals and groups opposed to growth in government across the board. Many of the arguments made against a Department of Science and Technology were highly pragmatic, as illustrated by Harvey Brooks's 1961 memorandum to Presidential Science Advisor Jerome B. Wiesner:

> Science and technology, regarded as ends in themselves, or as purely cultural activities, do not attract public support, at least on the scale which is now required. Support of science on this scale can only be sold to the public and to Congress by identifying it with specific desirable social goals such as the curing of disease, the enhancement of national security or national prestige, or the protection of public health or safety.[12]

Although Congress chose not to create a Department of Science and Technology, the need for coordination of the nation's science activities was nevertheless again brought forward for debate. That debate undoubtedly contributed to reorganization of the science policy apparatus within the Executive Branch, in particular, the creation of the Office of Science and Technology in 1962.

## Science Policy Under President Eisenhower

Unlike Congress and the news media, the Eisenhower Administration initially downplayed in public the importance of *Sputnik*. Nevertheless, the Soviet satellite did stir profound concern within the Administration for the state of science in the United States and led to two major White House initiatives to improve the Ad-

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[11] Wallace R. Brode, "Development of a Science Policy," in Robert H. Kargon (ed.), *The Maturing of American Science* (Washington: American Association for the Advancement of Science, 1974), p. 163.

[12] This memorandum was later published in Harvey Brooks, *The Government of Science* (Cambridge: The MIT Press, 1968), pp. 1–18. Quotation taken from page 11. See also, George H. Daniels, "The Pure-Science Ideal and Democratic Culture," *Science*, 156 (June 30, 1967), 1699–1705; and Harvey Brooks, "The Problem of Research Priorities," *Daedalus*, 107 (Spring 1978), 171–190.

ministration's use and coordination of science. The first was the creation of a Special Assistant for Science and Technology within the White House. This new position was promptly filled by the appointment of Massachusetts Institute of Technology president James R. Killian on 7 November 1957, thus making him the nation's first full-time Presidential science advisor.[13]

### PESIDENT'S SCIENCE ADVISORY COMMITTEE (PSAC)

President Eisenhower also created the President's Science Advisory Committee (PSAC) in 1957. This was part of a reorganization which put the former Science Advisory Committee of the Office of Defense Mobilization into the White House. First established in 1951, the Science Advisory Committee was little used until Eisenhower's tenure. The elevation of this advisory committee to the White House increased the frequency and intensity of the President's meetings with scientific advisors. Indeed, scientists became regular policy advisors, with their access to the President only surpassed by the conditions that existed during World War II. PSAC's first major task was space policy, although it also offered advice and recommendations on a wide range of public policy issues, and provided the White House with new lines of communication with the nation's scientific community.[14]

The creation of PSAC and the Special Assistant for Science and Technology significantly increased the influence of scientists at the highest level of government, giving them an institutionalized policy voice. Congress, however, found itself limited from participating fully in the formation of Federal science policy largely because the new Special Assistant was insulated from Congressional committee questioning. Congress' frustration over this situation helped fuel the unsuccessful efforts to establish a Department of Science and Technology.[15]

### FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY

In December 1958, the President's Science Advisory Committee recommended that a Federal Council for Science and Technology (FCST) be created in order to provide central, coordinated control over Federal research and development.[16] The Committee ex-

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[13] For Eisenhower's appointment of a Special Assistant for Science and Technology, as well as the overall development of Presidential science advice, see William G. Wells, Jr., "Science Advice and the Presidency, 1933–1976," Ph.D. dissertation, George Washington University, 1977; and James Everett Katz, *Presidential Politics and Science Policy* (New York: Praeger, 1978). Also useful are "White House Superstructure for Science," *Chemical & Engineering News,* 42 (October 19, 1964), 78–92; James R. Killian, Jr., *Sputnik, Scientists, and Eisenhower: A Memoir of the First Special Assistant to the President for Science and Technology* (Cambridge: The MIT Press, 1977); and George B. Kistiakowsky, *A Scientist at the White House: The Private Diary of President Eisenhower's Special Assistant for Science and Technology* (Cambridge: Harvard University Press, 1976).

[14] See Robert N. Kreidler, "The President's Science Advisers and National Science Policy" in Robert Gilpin and Christopher Wright (eds.), *Scientists and National Policy-Making* (New York: Columbia University Press, 1964), pp. 113–143; and William T. Golden (ed.), *Science Advice to the President* (New York: Pergamon Press, 1980).

[15] See National Academy of Sciences, *Federal Support of Basic Research in Institutions of Higher Learning* (Washington: National Research Council, 1964), pp. 54–55.

[16] President's Science Advisory Committee, *Strengthening American Science* (Washington: GPO, 1958). For a full discussion of the FCST, see U.S. Congress, House Committee on Science and Technology, *Interagency Coordination of Federal Scientific Research and Development: The Federal Council for Science and Technology* (94th Congress, 2nd session. Washington: GPO, 1976).

plained that the Federal Government was paying for about half of all the nation's research and development, and that it did so through the diversified programs of the various agencies: most notably the Department of Defense, the National Aeronautics and Space Administration, the Department of Health, Education, and Welfare, the Atomic Energy Commission, the National Science Foundation, and the Departments of Agriculture, Commerce, and Interior. Despite PSAC's advisory capacities within the White House, the part-time status of its members and its lack of budgetary authority prevented it from effectively coordinating the planning and management of scientific research and development as it took place within these various agencies. Recognizing this, PSAC called for the creation of an interagency council as a partial solution to this problem. In the words of the Committee:

> Each agency and department continues to formulate its own policies in science and technology with insufficient reference to the policies of others. Without in any way encroaching upon the freedom and authority of each department or agency to manage its own programs, there is still an opportunity to pull together the policies developed in different agencies of the Government with a view to integrating and reconciling them as a whole.[17]

President Eisenhower agreed with the recommendations of his Science Advisory Committee, and established the Federal Council for Science and Technology on 13 March 1959.[18] The FCST replaced the ineffectual Interdepartmental Committee on Scientific Research and Development. Following PSAC's advice, membership of the Council was made up of the heads of all Federal agencies responsible for scientific research and development. Their role was to consider research-related problems that cut across the various missions of their agencies and to make recommendations to the President and Congress.[19]

## Science Policy Under President Kennedy

The Executive Branch of the government made great strides toward strengthing its ability to formulate science policy in the years immediately after *Sputnik,* and the advances started by President Eisenhower were continued during the Kennedy Administration.[20] The most significant change affecting science policy was the establishment of the Office of Science and Technology (OST) within the Executive Office of the President. Created on 8 June 1962, OST was part of Reorganization Plan No. 2 of 1962. Like the Federal Council for Science and Technology, OST was intended to coordinate the Federal science policy—a role NSF had failed to achieve, and a role Congress sought to fulfill through its

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[17] President's Science Advisory Committee, *Strengthening American Science,* p. 10.

[18] Executive Order No. 10807, 13 March 1959.

[19] For the changing memberships of the FCST and its various subcommittees, as well as summaries of its numerous activities, see the *Annual Reports* of the FCST (which were published by the President's Office of Science and Technology) for the years 1962–1969.

[20] Kennedy's Special Assistant for Science and Technology, Jerome B. Wiesner, recalled the President's interests and activities in science policy in *Where Science and Politics Meet* (New York: McGraw-Hill, 1965), pp. 3–12.

proposed Department of Science and Technology. OST absorbed the science policymaking responsibility from NSF, although the Foundation was still charged with providing staff support and science policy proposals and recommendations to OST.[21]

This reorganization was brought about in part at the urging of Congress—most notably the Senate Committee on Government Operations—which had protested the fact that the President could refuse to allow his Special Assistant for Science and Technology to appear before Congressional committees.[22] This problem was solved with the creation of OST as the Special Assistant was moved from the White House to the Executive Office of the President. OST also answered Congressional concerns over the general lack of coordination and central control of the growing Federal research and development efforts. Thus, some of the principal rationales for the creation of a separate department of science and technology were removed.[23]

## Congress and Science Policy

From the establishment of the Office of Scientific Research and Development during World War II to the creation of the Office of Science and Technology in 1962, the Executive Branch took the lead in the formation of science policy in the United States. Up to this point, Congress played a more limited role in science policymaking.[24] Unhappy with this situation and concerned about recent trends within the Federal sponsorship of research, some members of Congress attempted therefore to strengthen their body's role in formulating scientific research and development policy. A principal concern within Congress was the exponential growth in Federal expenditures for research and development. Such a growth rate, it was realized, could not continue indefinitely, and fiscal conservatives from both parties sought to reduce this increase. Disputes over the geographic distribution of Federal research and development funds also stirred interest within Congress. On the issue of policy, many Congressional members were concerned with coordinating the research programs housed within the numerous departments and agencies, as well as with improving the structure of scientific advice to the Government.[25]

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[21] See U.S. Congress, Senate Committee on Government Operations, *Organizing for National Security: Science, Technology, and the Policy Process,* hearings before the Subcommittee on National Policy Machinery (86th Congress, 2nd session. Washington: GPO, 1960); and U.S. Congress, Senate Committee on Government Operations, *Organizing for National Security: Science Organization and the President's Office,* a study prepared by the Subcommittee on National Policy Machinery (Washington: GPO, 1961). For a compilation of background materials to the creation of OSTP, see U.S. Congress, House Committee on Science and Astronautics, *Creation of the Office of Science and Technology (Reorganization Plan No. 2, 1962)* (87th Congress, 2nd session. Washington: GPO, 1962).

[22] The Special Assistant, for example, was not allowed to appear before Congressional hearings on the possible creation of a Department of Science.

[23] See National Academy of Sciences, *Federal Support of Basic Research,* p. 55.

[24] See Stephen Toulmin, "The Historical Background to the Anti-Science Movement," in Ciba Foundation, *Civilization and Science: In Conflict or Collaboration?* (Amsterdam: Associated Scientific Publishers, 1972), pp. 30–31; and S.S. Podnos, "Research and Development—and the Congress," *The GAO Review,* 5 (Spring 1968), 40–46.

[25] See Kenneth Kofmehl, "COSPUP, Congress, and Scientific Advice." *Journal of Politics,* 28 (1966), 112; and Alton Frye, *The Legislative Role in Science Policy: Congressional Perspectives and Mechanisms* (Los Angeles: Institute of Government and Public Affairs, University of California, Los Angeles, 1966).

### ELLIOTT COMMITTEE

In response to these growing concerns within Congress, Representative Carl Y. Elliott, Democrat of Alabama, introduced a resolution to create a select committee to look into the nation's science policy. Elliott's resolution gained wide support, and on 11 September 1963, the House of Representatives created the Select Committee on Government Research with the charge of reviewing the Federal Government's research programs housed in some nine executive departments and 12 agencies.[26] The Committee was to examine:

> (1) the overall total amount of annual expenditures on research programs; (2) what departments and agencies of the Government are conducting research and at what costs; (3) the amounts being expended by the various agencies and departments in grants and contracts for research to colleges, private industry, and every form of student scholarships; (4) what facilities, if any, exist for coordinating the various and sundry research programs, including grants to colleges and universities as well as scholarship grants.[27]

The Committee was also to investigate the sensitive political question of the geographical distribution of funds for university research. Elliott was appointed chairman of the Committee, and membership was composed of ranking members from those standing committees with jurisdiction over Federal research and development activities. Hearings were held in November-December 1963 and January 1964,[28] while the Committee staff oversaw the preparation of ten major reports, the last of which was published at the end of the 88th Congress.[29] Although the Committee's purpose was not legislative in intent, it submitted over 40 specific recommendations.[30]

One of the most far-reaching recommendations of the Select Committee on Government Research was the proposal to create a

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[26] Members of the Select Committee on Government Research included Democrats Carl Y. Elliott (Chairman), John F. Fogarty, George P. Miller, Melvin Price, and Phil M. Landrum, and Republicans Clarence J. Brown (Ranking Minority Member), John B. Anderson, James C. Cleveland, and Patrick Minor Martin.

[27] House Resolution 504, submitted on 27 August 1963, considered and agreed to on 11 September 1963.

[28] See U.S. Congress, Select Committee on Government Research of the House of Representatives, *Federal Research and Development Programs* (88th Congress, 2nd session, parts 1–3. Washington: GPO, 1964).

[29] The ten major studies submitted by the Elliott Committee included: *Administration of Research and Development Grants, Manpower for Research and Development, Federal Facilities for Research and Development, Documentation and Dissemination of Research and Development Results, Federal Student Assistance in Higher Education, Impact of Federal Research and Development Programs, Contract Policies and Procedures for Research and Development, Interagency Coordination in Research and Development, Statistical Review of Research and Development,* and *National Goals and Policies.* These studies were all issued in 1964 by the Select Committee on Government Research of the House of Representatives (88th Congress, 2nd session). Part II of Study Number X, *Staff Resume of the Activities of the Select Committee on Government Research,* was published in 1965 (89th Congress, 1st session), and contains background material on the overall study and summaries of the ten reports.

[30] These recommendations are spread throughout the ten substantive studies, but are summarized in *Staff Resume,* pp. 19–27. Elliott was defeated in the 1964 Alabama primary, and the Select Committee—which required reestablishment with each new Congress—was disbanded in the 89th Congress as no Committee member stepped forward to assume the vacant chairmanship.

Joint Committee on Research Policy. According to the Committee's report:

> A joint committee should be organized as a counterpart to the Office of Science and Technology, the Federal Council on Science and Technology, and the President's Science Advisory Committee complex in the executive branch. In this sense, it would be comparable to the Joint Economic Committee which is the legislation counterpart to the Council of Economic Advisers within the executive.[31]

The intent of the proposed Joint Committee was not to replace the existing committees with jurisdiction over research and development, but to provide an overall view and coordinating capacity. However compelling this argument appeared to its proponents, it faced insurmountable opposition within the turf-conscious House of Representatives.

### DADDARIO SUBCOMMITTEE

Even the creation of Elliott's temporary Select Committee on Government Research exercised several Congressmen who viewed their committee's jurisdiction threatened. The Armed Services Committee and the Committee on Science and Astronautics went so far as to create their own subcommittees on research.[32] Science and Astronautics Committee Chairman George P. Miller, Democrat of California, established the Subcommittee on Science, Research and Development on 23 August 1963 with Representative Emilio Q. Daddario, Democrat of Connecticut, as chairman. When the Elliott resolution to establish the Select Committee came up for roll call vote on 11 September, Miller remarked:

> Investigation into research and development has to begin someplace, and perhaps this is as good a place as any . . . I am certain the Committee on Science and Astronautics will cooperate with the new committee, but it will protect its own interests and will fight against any duplication of effort in those areas in which the House of Representatives has given it statutory jurisdiction.[33]

The Daddario subcommittee—charged with the overall evaluation of the nation's research and development efforts, improving the use of scientific and engineering resources to meet national goals, developing scientific advisory mechanisms within Congress, and overseeing the National Science Foundation—quickly began its own special study into essentially the very same issues explored by the Elliott Committee. Hearings were held in October and November 1963, and were followed by the publication of a series of five reports.[34] The Daddario subcommittee continued its probing of the

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[31] Select Committee on Government Research, *National Goals and Policies,* p. 55.

[32] See Ken Hechler, *Toward the Endless Frontier: History of the Committee on Science and Technology, 1959-79* (Washington: GPO, 1980), pp. 130-132; and D. S. Greenberg, "Elliott Committee: Final Reports Issued as 15-Month Investigation of Federal Research Comes to End," *Science,* 147 (January 8, 1965), 131-132.

[33] Quoted in Hechler, *Toward the Endless Frontier,* p. 131.

[34] See U.S. Congress, House Committee on Science and Astronautics, Subcommittee on Science, Research and Development, *Government and Science,* 5 volumes: No. 1, *A Statement of*

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nation's science policy in 1965 when it began an extensive review of the National Science Foundation's charter of 1950. Joined later by Democratic Senator Edward M. Kennedy of Massachusetts, the Daddario review culminated in the 1968 amendments to the NSF charter.[35]

Unlike the House, the Senate did not have a single committee with legislative and oversight responsibilities for science. Although the creation of the Subcommittee on Government Research within the Government Operations Committee in 1965 did not resolve this, it did provide the Senate with a new lens through which to focus on certain broad aspects of the Federal science program. The Subcommittee on Government Research was chaired by Senator Fred R. Harris, Democrat of Oklahoma, and examined such issues as the geographical distribution of research and development funds, the support of the social sciences, the Federal contract and granting systems with universities, and the promotion of applications of biomedical knowledge. Despite its usefulness in concentrating attention of Government research issues, the subcommittee was disbanded at the end of the 90th Congress in 1969, at which time the full committee assumed its legislative responsibilities in the field of scientific research.[36]

In order to assist the Elliott and Daddario committees, as well as the other committees and Members of Congress in need of an impartial source of scientific and technical information, the Legislative Reference Service of the Library of Congress established a Science Policy Research Division in 1964.[37] In addition, the House Committee on Science and Astronautics began strengthening its own professional staff and assembled a Research Management Advisory Panel. Expansion of such support services was an attempt by Congress to supply itself with an independent source of scientific information and analysis, thus freeing itself from the Executive Branch and providing a balance to the President's Office of Science and Technology.[38]

### Committee on Science and Public Policy

Congress also turned to the National Academy of Sciences for independent advice on matters dealing with science and technology. From its inception during the Civil War, the Academy was charged

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*Purpose* (88th Congress, 1st session. Washington: GPO, 1963); No. 2, *Fiscal Trends in Federal Research and Development* (88th Congress, 2nd session, 1964); No. 3, *Scientific-Technical Advice for Congress: Needs and Sources* (88th Congress, 2nd session, 1964); No. 4, *Geographic Distribution of Federal Research and Development Funds* (89th Congress, 1st session, 1965); and No. 5, *Indirect Costs under Federal Research Grants* (89th Congress, 1st session, 1965).

[35] Public Law 90-407. See also, U.S. Congress, House Committee on Science and Astronautics, *The National Science Foundation: A General Review of Its First 15 Years* (89th Congress, 2nd session. Washington: GPO, 1965); and U.S. Congress, Senate Committee on Labor and Public Welfare, *National Science Foundation Act Amendments of 1968*, hearings before the Special Subcommittee on Science (90th Congress, 1st session. Washington: GPO, 1968).

[36] See Dorothy Bates, "The History of Federal Science Policy, 1787–1970," in U.S. Congress, House Committee on Science and Astronautics, *Toward a Science Policy for the United States* (91st Congress, 2nd session. Washington: GPO, 1970), p. 97.

[37] See George E. Lowe, "Congress and Science Advice," *Bulletin of the Atomic Scientists*, 21 (December 1965), 39–42; "A Wenk Legacy: Science-Policy Staff for Congress," *Washington Science News*, 1 (November 1966), 25–26; and Frank Sartwell, "Effective Advisers to Congress," *Science News*, 91 (April 8, 1967), 335.

[38] See Emilio Q. Daddario, "Setting Technological Goals in a Pluralistic Society," *Air Force and Space Digest*, 47 (April 1964), 56; Clinton P. Anderson, "Scientific Advice for Congress," *Science*, 144 (April 3, 1964), 29–32; and Frye, *The Legislative Role in Science Policy*.

with advising the Federal Government upon request on scientific and technical issues. However, despite the fact that the Academy freely provided such advice, its work had been predominantly oriented toward the Executive Branch. Such had been the case even during the early months of the Academy's newly-created Committee on Science and Public Policy (COSPUP). The Academy established the Committee on Government Relations in 1961 (it was renamed COSPUP in February 1963) as a means of expanding its participation in the formation of national science policy and to provide advice concerning the status and needs of particular scientific disciplines.[39] Under the chairmanship of George B. Kistiakowsky, a former science adviser to President Eisenhower, COSPUP cultivated close working relations with several Federal agencies and departments and began preparing a number of detailed studies at their request.[40]

Yet the Academy leadership was also interested in improving its organization's relations with Congress, especially in light of their desire to enlarge the Academy's science policymaking role. Having announced the Academy's willingness to expand its services to Congress, Academy President Frederick Seitz met with House Committee on Science and Astronautics Chairman George P. Miller and Subcommittee on Science, Research and Development Chairman Emilio Q. Daddario in December 1963. A formal agreement was reached in which the National Academy of Sciences would advise the Congress on science policy issues. More specifically, it was decided that COSPUP would undertake a series of studies for the Daddario Subcommittee which would be financed by, and made available to, Congress. As a result of this arrangement, three studies were ultimately prepared.[41]

Despite the usefulness of these studies and the link to the scientific community which COSPUP offered Congress, close and sustained working relations between COSPUP and Congress were never developed. This was a result of several factors. Perhaps most importantly, COSPUP and the National Academy of Sciences never lost their Executive Branch orientation. Key COSPUP and Academy members maintained close ties (official and unofficial) with numerous executive agencies and advisory groups, and conducted a

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[39] For the background of COSPUP, see Kormehl, "COSPUP, Congress, and Scientific Advice," pp. 100–120; and Harvey Brooks, "A Brief History of the Committee for Science and Public Policy of the National Academy of Sciences," unpublished paper, 1972, in the files of the Committee for Science, Engineering and Public Policy, National Academy of Sciences, Washington, D.C. My thanks to COSEPUP Executive Director Allan R. Hoffman for bringing both articles to my attention.

[40] COSPUP produced a number of specialized studies on specific scientific disciplines. Although these studies proved useful in setting Federal policy for the support of science within a particular field, they made no comparison between different fields of science and were therefore of limited assistance to those officials charged with making overall allocation decisions for science. These disciplinary reviews prepared by COSPUP and published by the National Academy of Sciences in Washington, D.C., included: *Ground-Based Astronomy: A Ten-Year Program* (1964), *Chemistry: Opportunities and Needs* (1965), *Physics: Survey and Outlook* (1966), *The Plant Sciences: Now and in the Coming Decade* (1966), *The Mathematical Sciences: A Report* (1968), *The Behavioral and Social Sciences: Outlook and Needs* (1969), *Report on the Life Sciences* (1970), and *Astronomy and Astrophysics for the 1970's* (1972). See also, William W. Lowrance, "The NAS Surveys of Fundamental Research 1962–1974, in Retrospect," *Science*, 197 (September 23, 1977), 1254–1260.

[41] The three COSPUP studies prepared for, and published by, the House Committee on Science and Astronautics were *Basic Research and National Goals* (1965), *Applied Science and Technological Progress* (1967), and *Technology: Process of Assessment and Choice* (1969).

multitude of studies for these organizations. Consequently, it was difficult for COSPUP to remain completely impartial and detached when working for Congress, which had the effect of clouding the full separation of powers within the Government. In addition, the requirement that Congress reimburse the Academy for studies done by COSPUP made it administratively difficult for individual committees to maintain a continuous relationship with COSPUP because funds for such external advice were not a normal part of a committee's budgetary authority. Finally, Congress became less reliant on external advice from organizations like COSPUP because it was expanding its own science advisory staff through the inclusion of more scientific and technical experts within its committee structure, as well as through the building up of the Science Policy Research Division of the Library of Congress.[42]

## Science Policy Under President Johnson

While Congress was grappling with its role in the science policymaking process, the new Johnson Administration attempted to reorient several aspects of the nation's postwar science policy. The most notable changes were in the Administration's emphases on the practical applications of scientific research and the wider geographical distribution of Federal research funding. In part, this was a reaction to the many spokesmen for science who made exaggerated promises during the late 1940s and 1950s about the practical results of basic research. After 20 years of listening to such promises, many people became impatient for results. This was especially true of decisionmakers within the Johnson Administration who were charged with implementing the policies of the Great Society.[43]

In an address to his Cabinet on 14 September 1965, President Johnson affirmed: "I am determined that we shall marshal our resources and our wisdom to the fullest to assure the continuing strength and leadership of American science and to apply the information yielded by its inquiry to the problems which confront our society and our purposes in the world." This support of the nation's research efforts was tempered by the former Texas Congressman's sympathy with arguments calling for increased geographical distribution of Federal research expenditures. Wanting to break the oligopoly on research funds alleged to be held by a small number of elite universities on the East and West coasts, the President stated:

> At present, one-half of the Federal expenditures for research go to 20 major institutions, most of which were strong before the advent of Federal research funds. During the period of increasing Federal support since World War II, the number of institutions carrying out research and providing advanced education has grown impressively. Strong centers have developed in areas which were previously not well served. It is a particular purpose of this

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[42] See Kofmehl, "COSPUP, Congress, and Scientific Advice," pp. 117-120; and Lowrance, "The NAS Surveys of Fundamental Research," pp. 1257-1260.

[43] For the development of science policy during the Johnson Administration, see W. Henry Lambright, *Presidential Management of Science and Technology: The Johnson Presidency* (Austin: University of Texas Press, 1985).

> policy to accelerate this beneficial trend since the funds are still concentrated in too few institutions in too few areas of the country. We want to find excellence and build it up wherever it is found so that creative centers of excellence may grow in every part of the nation.[44]

President Johnson's call for the redistribution of science funding was prompted in part by a recommendation made to the Federal Council for Science and Technology by the National Science Foundation earlier in 1965.[45] In April of that year, the NSF began issuing Science Development ("centers of excellence") Awards to colleges and universities that had not traditionally received large Federal science funding. Johnson's statement of 14 September 1965 reinforced this program and prompted the National Institutes of Health to respond in a similar fashion by beginning its Health Science Advancement Awards. The Department of Defense complied by establishing Project THEMIS in 1967—which was an attempt to provide defense-related research programs to universities not previously so engaged.[46]

The other major science policy concern of the Johnson Administration involved the application of research. There was a widely-held belief among White House staff members that publicly-financed research should be socially relevant—that the Government's heavy investments in science should result in tangible payoffs. This belief was clearly articulated in President Johnson's 15 June 1966 speech on the launching of Medicare in which he called for more immediate results from the research sponsored by the National Institutes of Health. He said:

> Now actually a great deal of basic research has been done. I have been participating in the appropriations for years in this field. But I think the time has now come to zero in on the targets by trying to get this knowledge fully applied. There are hundreds of millions of dollars that have been spent on laboratory research that may be made useful to human beings here if large-scale trials on patients are initiated in promising areas. Now Presidents, in my judgment, need to show more interest in what the specific results of medical research are during their lifetime, during their administration. I am going to show an interest in the results. Whether we get any or not I am going to show an interest in them.[47]

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[44] Lyndon B. Johnson., "Statement of the President to the Cabinet on Strengthening the Academic Capability for Science throughout the Nation," 14 September 1965, reprinted in James L. Penick, Jr., et al. (eds.). *The Politics of American Science: 1939 to the Present* (Cambridge: The MIT Press, 1972), pp. 334-336.

[45] See "Administrative History of the National Science Foundation during the Administration of President Lyndon B. Johnson, November 1963—January 1969," unpublished manuscript, National Science Foundation, pp. 239-241. My thanks to NSF Historian J. Merton England for bringing this document to my attention.

[46] See Lambright, *Presidential Management of Science and Technology*, pp. 80-84; and U.S. Department of Defense, *Project THEMIS* (Washington: Office of the Director of Defense Research and Engineering, 1967).

[47] See Lyndon B. Johnson, "Remarks at a Meeting with Medical and Hospital Leaders to Prepare for the Launching of Medicare," 15 June 1966, *Public Papers of the Presidents of the United States: Lyndon B. Johnson, 1966*, 2 books (Washington: GPO, 1967), book I, p. 610.

President Johnson's Medicare speech prompted vigorous protests and complaints from the biomedical research community.[48] These objections proved successful, as Johnson backed down on his proposed reforms in light of his damaged public image among academics. The presidential pressure for directed biomedical research was later resumed, however, by President Nixon with his "War on Cancer".[49]

Of greater significance to the nation's science policy was Johnson's escalation of the Vietnam War and the corresponding pressure it placed upon Federal civilian research budgets. Levels of Federal science funding had grown steadily since World War II, but the combined financial demands of the Vietnam War and the Great Society programs helped to break this trend in 1967. Other emerging issues—such as environmentalism, consumerism, nuclear energy debates, and general public criticism of science and technology—also helped stimulate a reassessment of the nation's postwar science policy.

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[48] See John Walsh, "NIH: Demand Increases for Applications of Research," *Science,* 153 (July 8, 1966), 149–152; Walter Sullivan, "Aide Bids Scientists Educate President on Work," *New York Times,* 25 October 1966; Stephen P. Strickland, *Politics, Science, and Dread Disease: A Short History of United States Medical Research Policy* (Cambridge: Harvard University Press, 1972), pp. 207–209; and Lambright, *Presidential Management of Science and Technology,* pp. 108–112.

[49] Lambright, *Presidential Management of Science and Technology,* pp. 111–112.

## VII. THE "CRISIS" IN GOVERNMENT/SCIENCE RELATIONS, 1965-1975

Between 1965 and 1975, protests revolving around the war in Vietnam, civil rights, environmental pollution, and the development of civilian nuclear power plants sparked a reexamination of conventional policy structures for science and created a demand for expanded scientific advice. There was a general increase in the public scrutiny of science, and scientists were increasingly viewed as an interest group susceptible to the same politics of open debate as everyone else. Skepticism about the claims of science grew, and Congress and the general public began questioning whether Government expenditures for research were benefiting the scientists and their institutions more than the public. And the scientific community began to worry that such questioning might well erode their support structure within the American political system. Many leaders within the science policy community thus came to view this as a period of "crisis" for science in the United States.[1]

Scientific research was also competing with new demands for funds. Many of the Great Society programs had begun to pull research and development funds away from established civilian and military programs. There was broad public support for the Great Society legislation and, hence, new calls for research to be socially relevant—that is, directed to help solve the nation's most urgent problems. This attitude was especially true for problems that science and technology were perceived to have created.

Not only did the various science budgets have to compete with the Great Society programs but escalation of the Vietnam War in 1965 also created new budgetary pressures. For the first time since the close of World War II, Federal support for basic research (when adjusted for inflation) actually began to decline in 1967.[2] This decline continued until the mid-1970s, when Federal funding levels began rising gradually, reaching the 1967 peak by 1982. Despite the fact that this decline was relatively small, the scientific community issued dire warnings. Harvard professor Harvey Brooks commented that this "decline occurred at a time when the accelerated output of science and engineering Ph.D.s resulting from the big expansion of federal support in the 60s began to be thrown onto the technical labor market. Thus the trauma was considerably greater than it

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[1] For a general discussion of the "crisis" in science during this period, see Don K. Price, "Science at a Policy Crossroads," *Technology Review*, 73 (April 1971), 30-37; Edward Shils, "Anti-Science: Observations on the Recent 'Crisis' of Science," in Ciba Foundation, *Civilization and Science: In Conflict or Collaboration?* (Amsterdam: Associated Scientific Publishers, 1972), pp. 33-49; and the special issue of *Daedalus*, "Science and Its Public: The Changing Relationship," 103 (Summer 1974).

[2] See John Walsh, "Science Policy: Budget Cuts Prompt Closer Look at the System," *Science*, 168 (May 15, 1970), 802-805.



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might have been, had the leveling off of funds not taken place in the face of a scientific establishment that was still growing''.[3]

In 1973, when President Nixon abolished the President's Science Advisory Committee and the Office of Science and Technology, scientists lost an important institutional policy voice. As opposition to the conduct of certain major areas of scientific research grew—most notably in recombinant DNA research, in research involving human subjects, and in fetal research—the sense of crisis deepened.

### The Environmental Movement

The environmental movement of the 1960s and 1970s had a significant impact on science policy. This was true in part because of the perception of a connection between many environmental controversies and the applications of post-World War II science and technology.[4] Radioactive fallout from above-ground nuclear weapons testing, growing concentrations of air pollution due largely to automobile exhaust, and the serious contamination of the nation's waters from industrial, agricultural, and municipal effluents began to arouse widespread public concern during the late 1950s, resulting in a host of environmental controversies. Paradoxically, science and technology were both blamed for such environmental problems and seen to promise their potential solutions.[5]

The publication of Rachel Carson's *Silent Spring* in 1962 sparked a heated public debate over the indiscriminate use of DDT and other chemical pesticides.[6] The Environmental Defense Fund (EDF) was established in 1967 largely to fight the use of DDT, but the importance of EDF extended beyond its specific success in opposing DDT. Its strategy of combining scientists, technologists, and lawyers also proved later to be a model for public interest organizations.[7]

The environmental movement contributed substantially to the growing criticism of sicence and technology. Public interest groups attempted to open science policy decisionmaking to greater public participation, thus increasing its accountability. Spokesmen for science funding now had to take into account environmental questions, as well as issues relating to consumer protection, the Vietnam War, and allocation battles with other social programs.

However, despite the potency and vociferousness of the environmental movement, there was only a minor build-up of Federal sup-

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[3] Harvey Brooks, "The Changing Structure of the U.S. Research System: A Historical Perspective on the Current Situation and Future Issues and Prospects," in Harvey Brooks and Roland W. Schmitt, *Current Science and Technology Policy Issues: Two Perspectives* (Occasional Paper No. 1. Washington: Graduate Program in Science, Technology, and Public Policy, George Washington University, 1985), p. 23.

[4] See Barry Commoner, *The Closing Circle: Nature, Man and Technology* (New York: Alfred A. Knopf, 1971).

[5] See Roderick Nash, *Wilderness and the American Mind* (New Haven: Yale University Press, 1982); Stephen Fox, *John Muir and His Legacy: The American Conservation Movement* (Boston: Little, Brown, 1981); and Samuel P. Hays, "From Conservation to Environment: Environmental Politics in the United States since World War Two," *Environmental Review*, 6 (Fall 1982), 14–41.

[6] Rachel Carson, *Silent Spring* (Boston: Houghton Mifflin, 1962). See also, Frank Graham, *Since Silent Spring* (Boston: Houghton Mifflin, 1970); and Ralph H. Lutts, "Chemical Fallout: Rachel Carson's *Silent Spring*, Radioactive Fallout, and the Environmental Movement," *Environmental Review*, 9 (Fall 1985), 210–225.

[7] See Thomas R. Dunlap, *DDT: Scientists, Citizens, and Public Policy* (Princeton: Princeton University Press, 1981), pp. 143–154.

port for environmentally-oriented research. Rather than expanding research, the effects were largely in the area of regulatory policy, much of it directed at overseeing technologies. The movement demanded rapid action—not the patience to wait for the findings of new research projects.[8]

### Debate Over the SST

The changing American attitudes toward technology and the environment were symbolized by the debate over supersonic transport. During the early 1960s, the Federal Government—largely due to the recommendations of NASA, the Federal Aviation Agency, and the Department of Defense—and the aerospace industry committed themselves to developing a commercial supersonic transport (SST), that is, a commercial aircraft capable of flying faster than the speed of sound. With the emergence of the environmental movement in the late 1960s and early 1970s, however, a public debate arose over the environmental consequences of the SST: primarily sonic booms and the potential for the destruction of the earth's ozone layer. The controversy became heated, and scientists were marshaled to provide evidence for both sides of the debate. This was especially true during the Congressional hearings between 1968 and 1971, at the end of which Congress terminated the SST program. Although the SST conflict really dealt with the nation's policy for technology rather than science, it signified new involvement for scientists in the political process, through Presidential science advice and Congressional testimony, as well as through involvement in citizen interest groups. And ultimately, it was a significant factor in President Nixon's disbandment of PSAC and OST.[9]

### Projects Hindsight and TRACES

Federal science budgets had grown rapidly during the late 1950s and early 1960s. With the overall budgetary pressures of the mid-1960s came increasing concern over the payoff of these expenditures on basic research. Spokesmen for the scientific community had been making claims for practical results flowing from basic research, yet these claims were never systematically substantiated. The Department of Defense, which had spent nearly ten billion dollars on research and development in the twenty years since World War II, attempted to examine the correlation between basic research and practical results through a retrospective study, *Project Hindsight*. The thirteen teams of scientists and engineers conducting the *Hindsight* study chose twenty currently deployed weapons systems deemed critical to the nation's defense, and looked back twenty years in order to determine the contribution of basic research to their development. They isolated seven hundred research "events" that led to the development of these weapons systems.

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[8] See Harvey Brooks, "The Changing Structure," pp. 24–25.

[9] See Mel Horwitch, *Clipped Wings: The American SST Conflict* (Cambridge: The MIT Press, 1982); and Joel Primack and Frank von Hippel, *Advice and Dissent: Scientists in the Political Arena* (New York: Basic Books, 1974), pp. 10–29. For the role of the National Academy of Sciences in this debate, see Philip M. Boffey, *The Brain Bank of America: An Inquiry into the Politics of Science* (New York: McGraw-Hill, 1975), pp. 113–142.

These events were classified as being either technological or scientific—the latter category being further classified as either mission-oriented or non-mission-oriented science, that is, basic research. Only nine percent of the events were classified as scientific, with only 0.3 percent (or two events) representing basic research.[10]

*Hindsight's* conclusion that technological achievements stemmed primarily from mission-oriented engineering research and development provoked immediate and angry reactions. The study was attacked from several angles. It was methodologically flawed, the critics argued, for only tracing the scientific inputs back twenty years. A longer time period would more accurately assess the contributions of basic research, for often practical results come long after initial discoveries. In addition, some critics claimed that the weapons systems chosen by the *Hindsight* researchers were not necessarily representative of types of payoffs most usually associated with basic research. Finally, they maintained that incremental technological changes were studied while major breakthroughs were ignored.

The reasons behind such criticisms extended beyond methodological concerns, however. *Project Hindsight* was also perceived as a considerable threat to the science policy establishment. For, one of the basic tenets of government support of scientific research—as argued forcefully by Vannevar Bush—was that basic research was the fountain from which technological progress flowed, and therefore the source of material advancement. Such arguments justified generous public support of basic research. *Hindsight,* however, challenged directly the notion that technological innovation is based on advances in science.

The most elaborate response to *Hindsight* was the sponsorship of an alternative study—*Project TRACES* [11]—by the National Science Foundation, an agency whose rationale was questioned by the findings of *Hindsight.* To correct the flaws attributed to the Department of Defense study, *TRACES* extended its historical analysis back fifty years and examined what the project directors considered major innovations.[12] Not surprisingly, *TRACES* reached the opposite conclusion from that of *Hindsight:* that basic research conducted at the nation's universities was the principal factor in the development of important technologies. It followed, therefore, that the Federal Government should continue its support of undirected research.

The debate over the economic and technological utility of basic research investments engendered by the *Hindsight* and *TRACES* studies was never fully resolved. Nevertheless, they did signal a

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[10] See Chalmers W. Sherwin and Raymond S. Isenson, *First Interim Report on Project Hindsight* (Washington: Office of the Director of Defense Research and Engineering, 1966); Chalmers W. Sherwin and Raymond S. Isenson, "Project Hindsight: A Defense Department Study of the Utility of Research," *Science,* 156 (June 23, 1967), 1571–1577; and Raymond S. Isenson, *Project Hindsight Final Report* (Washington: Office of the Director of Defense Research and Engineering, 1969).

[11] Illinois Institute of Technology Research Institute, *Technology in Retrospect and Critical Events in Science (TRACES),* 2 volumes (Washington: National Science Foundation, 1968). The NSF subsequently supported a follow-up study: Columbus Laboratories, *Interactions of Science and Technology in the Innovative Process: Some Case Studies* (Columbus, Ohio: Battelle Memorial Institute, 1973).

[12] These included magnetic ferrites, birth control pills, video recorders, electron microscopes, and matrix isolation.

change in the nation's science policy. The support of undirected research by Federal mission-oriented agencies began to decrease, especially within the armed services. The decline of the military as the Government's prime sponsor of basic research was accelerated by the pressures of the Vietnam War and later, in 1969, by the Mansfield Amendment.[13]

### Criticisms of Science From the Anti-War Movement

The Vietnam War had a profound impact on the Government-science relationship. University scientists working on Department of Defense research contracts found themselves under critical attack, and universities in general were criticized for supporting the war in Vietnam. Government-funded classified research was an important target of this criticism, which came from both students and faculty. Scientists and Engineers for Social and Political Action, later changed to Science for the People, and the Union of Concerned Scientists were two organizations that became deeply involved in these issues.

Prompted by the 1965 escalation of the Vietnam War, significant numbers of scientists also became politicized during the late 1960s and early 1970s. Many of them began speaking out against the military applications of their research which they viewed as a misuse of science and technology; other scientists simply spoke out more broadly against government policies. Their protests took place on college and university campuses across the country, as well as in the nation's capital.

Of the various protests by scientists against the Vietnam War and their attempts to move classified research off campus, perhaps the best known and most influential event was the research stoppage organized by students and faculty at the Massachusetts Institute of Technology on 3 and 4 March 1969.[14] Known widely as simply "March 4," these discussions and meetings were sponsored by the Union of Concerned Scientists and groups at M.I.T., and they received much publicity in the news media. It was a prime example of scientists publicly questioning the nation's science and technology policies as they related to the military support of classified research on college and university campuses, and their attempt to find alternatives, including a greater emphasis on research associated with civilian problems. As M.I.T. physicist Victor Weisskopf asserted at the meetings, "We scientists must try to make better use of science and to prevent its misuse".[15] In addition to helping raise the issue of military research nationally, March 4 contributed to a far-reaching change at M.I.T. itself: the decision in May 1970 to divest the Institute of the Charles Stark Draper Laboratory, which was a major recipient of Department of

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[13] See Harvey M. Sapolsky, "Science, Technology and Military Policy," in Ina Spiegel-Rösing and Derek de Solla Price (eds.), *Science, Technology and Society: A Cross-Disciplinary Perspective* (Beverly Hills: Sage Publications, 1977), pp. 454–455.

[14] See Jonathan Allen (ed.) *March 4: Scientists, Students, and Society* (Cambridge: The MIT Press, 1970); and Dorothy Nelkin, *The University and Military Research: Moral Politics at M.I.T.* (Ithaca: Cornell University Press, 1972).

[15] V. F. Weisskopf, "Intellectuals in Government," in Allen, *March 4*, p. 27.

Defense research funding and the largest research program at M.I.T.[16]

M.I.T. was not the first university to cut its ties with military-supported classified research centers. Similar decisions were made at Columbia University (Electronics Research Laboratory, 1967), Cornell University (Cornell Aeronautical Laboratory, 1969), Stanford University (Stanford Research Institute, 1970), and the University of Michigan (Willow Run Laboratories, 1972).[17]

### The Mansfield Amendment

Disenchantment with military support of basic research spread far beyond the nation's college campuses. In Congress, concern with this issue was manifested in the so-called "Mansfield Amendment" of 1969. This amendment was actually the controversial section 203 of the military authorization bill for fiscal year 1970.[18] Although introduced by Democratic Senator J. William Fulbright of Arkansas, the amendment acquired the name of its staunch and outspoken supporter, Senator Mike Mansfield, Democrat of Montana.[19] In the words of section 203:

> None of the funds authorized to be appropriated by this Act may be used to carry out any research project or study unless such a project or study has a direct or apparent relationship to a specific military function or operation.[20]

Thus, the Mansfield Amendment sought to curtail the Department of Defense from supporting general, nonmilitary-related basic research. Supporters of the amendment argued that Federally-funded basic research that sought solely to uncover fundamental knowledge should not be buried in the budget of the mission-oriented Department of Defense. The supporters stressed the need for Federal support of basic research, and called upon the National Science Foundation to provide a larger share of this funding.[21]

As a result of the Mansfield Amendment, the Department of Defense reviewed some 6,600 of its currently funded research projects, and determined that roughly four percent of these projects did not meet the relevancy test.[22] The Armed Services were given broader latitude in their support of research projects, however, when the language of the Mansfield Amendment was modified in the military authorization bill for fiscal year 1971 to read:

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[16] Prior to January 1970, the Draper Laboratory was known as the Instrumentation Laboratory. For a detailed analysis of the factors leading to M.I.T.'s divestiture of the Draper Laboratory, see Nelkin, *The University and Military Research*.

[17] See Bruce L. R. Smith and Joseph J. Karlesky, *The State of Academic Science: The Universities in the Nation's Research Effort* (New York: Change Magazine Press, 1977).

[18] Public Law 91-121.

[19] See Rodney Nichols, "Mission-Oriented R&D," *Science*, 172 (April 2, 1971), 29.

[20] See section 203 of Public Law 91-121.

[21] Mario Grignetti presented several arguments for removing the sponsorship of nonmilitary research from the Department of Defense at the March 4 M.I.T. protests. See Grignetti, "Some Proposals to Aid Reconversion," in Allen, pp. 40–41. See also, Nichols, "Mission-Oriented R&D"; Mike Mansfield, "Too Many Research Eggs in Defense Baskets?," *Christian Science Monitor*, 12 September 1970.

[22] This four percent translated into about $8.8 million out of the Department of Defense's total research and development budget of $223 million. See Dorothy Bates, "The History of Federal Science Policy, 1787–1970," in U.S. Congress, House Committee on Science and Astronautics, *Toward a Science Policy for the United States* (91st Congress, 2nd session. Washington: GPO, 1970), pp. 111–112.

> None of the funds authorized to be appropriated to the Department of Defense by this or any other act may be used to finance any research project or study unless such project or study has, in the opinion of the Secretary of Defense, a potential relationship to a military function or operation. [23]

Despite this change in language, the Mansfield Amendment had a long-lasting influence on how the Department of Defense justified its expenditures for scientific research by introducing both greater caution and uncertainty in the awarding of grants and contracts.

### Public Participation Movement

The social movements of the late 1960s and early 1970s contributed to a general movement to increase public participation in many areas of social decisionmaking, including the courts, law making, policy formation, and project review. Science policy was included in this.[24] Public interest environmental organizations such as the Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, and Friends of the Earth became involved in numerous issues that touched upon science and public participation. Often, these groups utilized their own scientists—usually working as volunteers from universities—to address agency compliance with environmental policies. The courts also were opened to broader public interest participation, most notably through the right of standing granted in the late 1960s to groups not necessarily suffering economic loss.

In the direct area of science policy, public participation was fostered through the establishment of several public interest science groups. These groups—such as Science for the People—challenged both Federal projects and policies, and helped set the national agenda. Although their participation ranged widely, they were often concerned with environmentally-related issues.

### 1970 Daddario Hearings

Between July and September 1970, the House Subcommittee on Science, Research and Development of the Committee on Science and Astronautics held a series of hearings reviewing the course of national science policy since World War II.[25] In large part championed by Subcommittee chairman Emilio Q. Daddario, Democrat of Connecticut, these hearings sought to reevaluate thoroughly the government-science relationship, and they served as the cutting edge of Congressional efforts to formulate national science policy. The Daddario Subcommittee addressed such concerns as the decline in Federal support of science, the impact of the Mansfield Amendment, the emphasis on applied research, and the growth of popular criticism of science.

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[23] See section 204 of Public Law 91-441.

[24] See James C. Petersen (ed.), *Citizen Participation in Science Policy* (Amherst: University of Massachusetts Press, 1984).

[25] See U.S. Congress, House Committee on Science and Astronautics, Subcommittee on Science, Research and Development, *Toward a Science Policy for the United States* (91st Congress, 2nd session. Washington: GPO, 1970).

As Daddario explained to Committee Chairman George P. Miller, Democrat of California, the Subcommittee undertook this study "not only because no congressional committee has ever looked at the matter in its entirety, but because it was clear that the Nation has no formalized science policy to guide it." In recommending that the Administration appoint a blue ribbon task force with the responsibility of drafting and submitting to Congress a "basic national science policy," Daddario asserted: "It is my conviction that unless such a combined legislative-executive effort is made and a feasible science policy worked out—the Nation will continue to flounder in its efforts to solve many of the great issues confronting it for want of adequate knowledge and understanding of the issues themselves." [26]

The Subcommittee's recommendation that "a National Science Policy be stated and maintained as a public law" [27] followed the model provided earlier in the year with the enactment of the National Environmental Policy Act.[28] In justifying the urgency for establishing such a policy by law, the Subcommittee highlighted the declining growth rates in the Federal support of science, the growing emphasis by the Government on mission-oriented research, the growing public criticism of science and technology, and the low morale of the scientific community in general. It went on to explain that:

> What makes the status of science so acute, however, is that it is a tool which, once dulled, is not easily or readily resharpened. Scientists and technicians are neither motivated nor trained quickly; and their facilities, if permitted to grow obsolete, can be made useful again only with great cost and the lapse of much time.[29]

The Subcommittee further recommended that the National Science Policy should "be incorporated into the operations of every department or agency of the U.S. Government which utilizes science and technology in its mission," and that "such a policy be flexible and subjected to continual review and reevaluation in light of changing national goals and priorities." [30]

## Science Policy Under President Nixon

The Nixon Administration did not abide by the Daddario Subcommittee's recommendation that it submit to Congress a formal proposal to establish a comprehensive science policy. But the Presi-

[26] Emilio Q. Daddario to George P. Miller, 15 October 1970, quoted in *Toward a Science Policy for the United States*, p. iii. See also, Emilio Q. Daddario, "Needs for a National Policy," *Physics Today*, 22 (October 1969), 33–38; Emilio Q. Daddario, "On National R&D Policy," *Astronautics and Aeronautics*, 8 (October 1970), 56–63; and Emilio Q. Daddario, "Many Today Tend to Use Science as a Whipping Boy," *Christian Science Monitor*, 12 September 1970.

[27] *Toward a Science Policy for the United States*, p. 10.

[28] The National Environmental Policy Act was signed into law by President Nixon on 1 January 1970 (Public Law 91-190). For the Congressional debates over the establishment of an overall policy for the environment, see Terence T. Finn, "Conflict and Compromise: Congress Makes a Law, the Passage of the National Environmental Policy Act," Ph.D. dissertation, Georgetown University, 1972.

[29] *Toward a Science Policy for the United States*, p. 8.

[30] *Ibid.*, p. 10, Compare this with the Daddario Subcommittee's report of the previous year: U.S. Congress, House Committee on Science and Astronautics, Subcommittee on Science, Research and Development, *Centralization of Federal Science Activities* (91st Congress, 1st session. Washington: GPO, 1969).

dent was interested in improving the Administration's ability to coordinate the nation's research activities. To assist him in this endeavor, Nixon created a Task Force on Science Policy in October 1969.[31] In its report to the White House, the Task Force stated that:

> National policy governing science and technology should in principle be a mirror image of our national goals and purposes. Science policy should in part be a statement about the priorities of the future.[32]

In order to accomplish this objective, the Task Force recommended that further support and responsibility be given to the President's Science Advisory Committee and the Office of Science and Technology. The Daddario Subcommittee was in complete agreement with the Task Force when it, too, recommended that the President's science advisory offices be "strengthened both as to staffing and mission." [33]

President Nixon, however, did not like the fact that his science advisers had often disagreed with him on issues central to his overall political objectives. The most notable examples were the scientists' objections to the supersonic transport (SST) and anti-ballastic missile (ABM) programs. Nixon also disliked the continued opposition to the Vietnam War expressed by many within the scientific community.[34] As a result, the President rejected the concurring recommendations of the Daddario Subcommittee and his own Task Force on Science Policy, choosing instead to abolish both PSAC and OST through his Reorganization Plan submitted on 27 January 1973. Nixon's reorganization—which was an attempt to strengthen the Presidency by increasing the size of the White House staff and consolidating its decisionmaking apparatus—affected many areas of domestic policymaking besides research, but the message it sent to the science policy community generated tremendous controversy.[35]

With the dismantling of PSAC, the role of Presidential science adviser was given to the Director of the National Science Foundation, at that time, H. Guyford Stever. Stever accepted this dual responsibility and was assisted in his Presidential advisory responsibilities by NSF's Science and Technology Policy Office.

Congress responded to the President's actions by looking into the legislative possibilities of restoring the White House Office of Science and Technology. Beginning in mid-1973, the House Committee on Science and Astronautics began a two-year review of science policy with the main focus on replacing the dismantled OST. This

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[31] Ruben F. Mettler, Executive Vice President of TRW, Inc. (subsequently elected President of TRW), was appointed chairman of the Task Force.

[32] U.S. President's Task Force on Science Policy, *Science and Technology: Tools for Progress* (Washington: GPO, 1970), p. 9.

[33] *Toward a Science Policy for the United States*, p. 11.

[34] See David Z. Beckler, "The Precarious Life of Science in the White House," *Daedalus*, 103, (Summer 1974), 115–134; and James R. Killian, Jr., *The Education of a College President: A Memoir* (Cambridge: The MIT Press, 1985), passim.

[35] For a general account of the dismantling of PSAC and OST, as well as the various responses to that, see John F. Burby, "Science Report: Congress Ready to Move on New Federal R&D Structure," *National Journal*, 6 (December 14, 1974), 1871–1876. The general development of science policy during the Nixon Administration is discussed in Sylvia D. Fries, "The Ideology of Science during the Nixon Years: 1970–76," *Social Studies of Science*, 14 (1984), 323–341.

effort was headed by Committee Chairman Olin E. Teague, Democrat of Texas. The Committtee held a series of hearings and commissioned several reports, all with the intention of helping to frame a national science policy and creating an organizational structure to carry it out.

This was part of a broader effort by Congress to increase its participation in the formation of national science policy and to increase its strength vis-á-vis the growing powers of the Presidency. It did this largely through an expansion of its oversight capacity. Like the mid-1940s, the early 1970s found the Congress concerned with moving the nation from a wartime to a peacetime economy, and Federal support of science was shaped by these considerations.

In their attempt to restore the White House Office of Science and Technology, neither scientists nor Members of Congress attacked Stever personally. He was generally well liked and respected. It was believed, however, that the NSF director should not divide his time between the directorship of NSF and Presidential science advising. Both were full–time jobs, argued the proponents of a renewed White House science and technology office.

## Impact of the Energy Crisis on Science Policy

The energy crisis was spurred by the oil embargo initiated by the Organization of Petroleum Exporting Countries in October 1973.[36] This embargo had a profound economic effect on the United States, and also had a significant effect on the nation's science policy. The resulting economic stagnation was considered by many to be associated, at least in part, with the decline in Federal funding of research and development. Efforts were made to correct this situation, and also to replace the science policy machinery lost during the Nixon Administration. Much of this science funding was targeted at economic recovery.

Efforts were also made to increase Government-supported research in the area of energy development. The build-up in Federal support of energy research took place largely within the Energy Research and Development Administration—an agency that was superseded during the Carter Administration by the Department of Energy.

## The War on Cancer

Continuing the trend stressed by the Johnson Administration, President Nixon emphasized applied research. In his State of the Union message on 22 January 1971, the President called for an additional $100 million "to launch an intensive campaign to find a cure for cancer." Alluding to the two large-scale and highly successful mission-oriented scientific efforts, the Manhattan Project and the Apollo program, Nixon went on to say:

> The time has come in America when the same kind of concentrated effort that split the atom and took man to the moon should be turned toward conquering this dread dis-

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[36] For a discussion of the energy crisis, see Martin V. Melossi, *Coping with Abundance: Energy and Environment in Industrial America* (Philadelphia: Temple University Press, 1985), pp. 277–294.

ease. Let us make a total national commitment to achieve this goal.[37]

Having launched its "War on Cancer," the Nixon Administration began placing great pressure on the biomedical community to move rapidly from basic research to development programs. Such a crash program tended to cut back on the breadth and diversity of basic research, and to concentrate on programs based on existing ideas.[38]

### Office of Technology Assessment

The Office of Technology Assessment (OTA) was founded in October 1972 to serve as a science advisory body for the Congress.[39] Like the General Accounting Office, the Congressional Budget Office, and the Congressional Research Service within their respective fields of expertise, OTA was a support agency meant to provide Congress with independent scientific and technical information.[40] It was intended that it would operate to free Congress from its dependency on the Executive Branch agencies for such information.

### Research Applied to National Needs (RANN)

The Nixon Administration's emphasis on applied research, manifested in the War on Cancer, was extended to the National Science Foundation during the early 1970s. As part of its attempt to stimulate the nation's faltering economy, the Office of Management and Budget [41] called on the NSF to increase its expenditures on applied research, while at the same time reducing the proportion of its funding for educational and institutional endeavors. The result was the establishment in 1971 of a program called Research Applied to National Needs, or RANN. The creation of RANN was really the expansion of a more modest NSF program, entitled Interdisciplinary Research Relevant to Problems of Our Society, which had been established in 1968.[42]

RANN received mixed reactions from the science policy community. The Association of American Universities, for example, worried that RANN was yet another example of the Federal Government's post-1966 shift in science policy toward support of targeted or applied research.[43] Many scientists were openly concerned that the NSF's basic research mission might be undermined by inclusion of the new program. It was pointed out that RANN received

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[37] "Annual Message to the Congress on the State of the Union," 22 January 1971, in *Public Papers of the Presidents of the United States: Richard Nixon, 1971* (Washington: GPO, 1972), 53.

[38] See Dorothy Nelkin, "Technology and Public Policy," in Spiegel-Rösing and Price (eds.), *Science, Technology and Society*, pp. 402–403.

[39] Public Law 92–484. Former Representative Emilio Q. Daddario was the first Director of OTA. For the background of the technology assessment idea, see Carroll Pursell, "Belling the Cat: A Critique of Technology Assessment, "*Lex et Scientia*, 10 (October-December 1974), 130–145.

[40] Both the General Accounting Office and the Congressional Research Service stepped up their efforts in assessing science and technology policy during the 1960s.

[41] When reorganized in 1970, the Bureau of the Budget was renamed the Office of Management and Budget.

[42] See Milton Lomask, *A Minor Miracle: An Informal History of the National Science Foundation* (Washington: National Science Foundation, 1976) pp. 237–250; and John T. Wilson, *Academic Science, Higher Education, and the Federal Government: 1950–1983* (Chicago: University of Chicago Press, 1983), pp. 34–38.

[43] See Smith and Karlesky, *The State of Academic Science*, pp. 32–37.

8.6 percent of the NSF budget in 1972, and that RANN's share rose to 13 percent in 1974.[44] But these figures were somewhat misleading. Although RANN did enlarge the Foundation's support of applied research through funds distributed by its three subdivisions—Social Systems and Human Resources, Advanced Technology Applications, and Environmental Systems and Resources—the NSF remained firmly committed to the fostering of basic research. In fact, the very name RANN was chosen deliberately because of its use of the phrase "research applied," as distinct from "applied research."[45] Moreover, nearly 40 percent of RANN's budget was eventually allocated to the pursuit of new scientific knowledge.[46]

## Science Policy Under President Ford

When Gerald Ford became President upon Nixon's resignation from office in August 1974, several changes were made in the nation's science policy.[47] For one thing, the Ford Administration was sympathetic to restoring the Presidential science advisory machinery, and there was a fair amount of cooperation between the White House staff, Congress, and the National Science Foundation on this issue. On 21 December 1974, Vice President Nelson Rockefeller was officially assigned the task of investigating the advisability of reestablishing the science advisory system within the White House.

Because Ford wanted the science office established by Congressional legislation rather than by Presidential order, both the House and Senate worked on legislation to create such an office. Rockefeller and his staff conferred closely with Congress and the National Science Foundation. His report on this issue was presented on 5 February 1975. On 9 June 1975 the Administration introduced its bill to create an office of science and technology policy within the Executive Office. After numerous hearings and Congressional debate, on 11 May 1976, President Ford signed into law the National Science and Technology Policy, Organization, and Priorities Act.[48]

This legislation was the outcome of dozens of hearings and reports, and of compromises between the Administration and Congress. The new law provided a statement of national policy for science and technology. It also established the Office of Science and Technology Policy (OSTP) within the Executive Office of the President. Although a formal President's Science Advisory Committee was not established, the director of the OSTP was to serve as the President's science adviser. The OSTP director also chaired the Federal Coordinating Council for Science, Engineering, and Technology that replaced the Federal Council for Science and Technology founded in 1959. President Ford nominated NSF Director H.

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[44] By 1976, however, RANN's proportion of the NSF budget dropped to 10 percent. Two years later, RANN was abolished as a program within the NSF. See *Ibid.*, p. 34; and Jarleth Ronayne, *Science in Government* (London: Edward Arnold, 1984), pp. 119–124.

[45] See Lomask, *A Minor Miracle*, p. 244.

[46] *Ibid.*

[47] For a brief overview of science policy issues during the Ford Administration, see Claude E. Barfield, *Science Policy from Ford to Reagan: Change and Continuity* (Washington: American Enterprise Institute for Public Policy Research, 1982), pp. 1–9.

[48] Public Law 94-282. For an analysis of the Congressional hearings leading up to this act—notably for an analysis of the testimonies of the scientists at these hearings—see Fries, "The Ideology of Science during the Nixon Years," pp. 323–341.

Guyford Stever, who was sworn in as the first OSTP director on 12 August 1976.[49]

THE rDNA RESEARCH CONTROVERSY

Nothing heightened the debate over the Government regulation of basic research more than the advent of recombinant DNA (rDNA) research during the early 1970s. In January 1973, a small group of researchers met at the Asilomar Conference Center in Pacific Grove, California, to discuss the potential hazards of rDNA research.[50] Organized by the scientists themselves, this conference was an attempt to discuss the advisability of self-regulation by the recombinant DNA researchers.

The debate continued, and in 1974 the scientists called for a voluntary worldwide moratorium on high-risk recombinant DNA experiments.[51] The debate was not limited to scientific concerns, however, as legal, political, social, and philosophical questions were raised as well.

To assist the Director of the National Institutes of Health with all issues relating to the regulation of recombinant DNA research, the NIH established the Recombinant DNA Molecule Program Advisory Committee on 7 October 1974. Its name was later changed to the Recombinant DNA Advisory Committee—or "RAC".

In February 1975, another meeting was held at Asilomar to discuss the issues—this meeting jointly financed by the NSF and the National Cancer Institute. The 155 invited participants consisted of leading biological scientists from universities and industry, government officials, lawyers, and news media representatives. After heated debate that covered a wide range of issues, a list of recommendations was drafted and released.

RAC drew upon these recommendations when drafting its guidelines for laboratory practice. On 15 June 1976, the National Institutes of Health issued its "Guidelines for Research Involving Recombinant DNA," which became the standard for Federal regulation of such research.

The rDNA controversy has been called "an unprecendented chapter in the annals of basic scientific research and in the governance of modern science as a social institution."[52] And without question its impact on science policymaking was profound. For one thing, it brought into the science policymaking arena a whole new group of players—for the most part biologists. In contrast, since

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[49] See U.S. Congress, Senate, Committee on Commerce, Science, and Transportation and Committee on Human Resources, *A Legislative History of the National Science and Technology Policy, Organization, and Priorities Act of 1976* (95th Congress, 1st session. Washington: GPO, 1977).

[50] The literature on the recombinant DNA controversy is rich. See, for example, David A. Jackson and Stephen P. Stich (eds.), *The Recombinant DNA Debate* (Englewood Cliffs: Prentice-Hall, 1979); Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy* (Cambridge: The MIT Press, 1982); Joan Morgan and W. J. Whelan (eds.), *Recombinant DNA and Genetic Experimentation* (New York: Pergamon Press, 1979); Judith P. Swazey, James R. Sorenson, and Cynthia B. Wong, "Risks and Benefits, Rights and Responsibilities: A History of the Recombinant DNA Research Controversy," *Southern California Law Review*, 51 (1978), 1019–1078; and Nicholas Wade, *The Ultimate Experiment: Man-Made Evolution* (New York: Walker, 1979).

[51] The call for a rDNA research moratorium was printed as a letter to the editor in *Science*, 185 (July 26, 1974), 303.

[52] Swazey, et al., "Risks and Benefits, Rights and Responsibilities," p. 1019.

World War II, physicists had been the dominant scientific group involved in policymaking. It also served to raise a new set of issues for science policymakers, ranging from ethical considerations to the strict government regulation of research.[53]

## Summary

The period between 1965–1975 was one of readjustment for science policymakers in the United States. For the first time since World War II, the steady pattern of real growth in the Federal funding of research was broken. At the same time, criticisms of science and technology grew among several segments of society, much of the criticism associated with the social and political protests against the war in Vietnam and environmental pollution. Within the Executive Office of the President, scientists lost their formal advisory mechanisms when PSAC and OST were dismantled in 1973. Diligent work within the Congress and the Ford Administration restored the scientific advisory system in 1976. Federal expenditures for research and development were also climbing once again at the time of the nation's bicentennial. Nevertheless, the perceived crisis in science policy of the previous decade led many representatives of the scientific community to worry about the overall health of the nation's research endeavor.

[53] I would like to thank Marcel C. LaFollette of M.I.T. for bringing these ideas to my attention.

## VIII. CHANGE AND CONTINUITY IN U.S. SCIENCE POLICY, 1975-85

Federal science policy during the period 1975-1985 was influenced by changes in the economic and social context brought about by the energy crisis and economic stagflation. Both Presidents Carter and Reagan sought to increase Federal support of basic research, believing that advances in science and technology would help improve the international competitiveness of American industry and strengthen the domestic economy.[1] Several themes recurred in the debates over science policy in both the Carter and Reagan Administrations. One of these was the question of what should be the rationale for the public funding of scientific research. The Carter Administration tended to stress Federal involvement as an "investment" for the future, often directed at solving major national problems. During the Reagan Administration, expenditures for research were rationalized largely by looking either at the ultimate application for industrial competitiveness or, more specifically, at military application. Although the administrative choices and political strategies were often the same for Carter and Reagan, the metaphors they employed were different. At the same time, representatives of the scientific community began increasingly to stress that Federal decisions on the support of research should rely primarily on the needs of scientists, rather than on directed applications. This emphasis was clearly manifested in the scientists' reaction to the political circumvention of the peer review system as it occurred in several instances of funding large-scale research projects.

### Science Policy Under President Carter

The Carter Administration placed great importance upon the Federal support of research and development. The promotion of basic research figured prominantly in the Administration's science policy, and it sought to provide real growth in expenditures for such research by the National Science Foundation and the Departments of Agriculture, Defense, and Energy. Beyond expanding Federal funding for basic research, President Carter's science policy emphasized that Federally funded R&D should: (1) stimulate innovation in industry, help sustain economic growth, and improve pro-

[1] For a thorough discussion of the development of science policy during the Carter and Reagan Administrations, see David Dickson, *The New Politics of Science* (New York: Pantheon Books, 1984). Also useful are J. Ronayne, *Science in Government* (London: Edward Arnold, 1984); Claude E. Barfield, *Science Policy from Ford to Reagan: Change and Continuity* (Washington: American Enterprise Institute for Public Policy Research, 1982); William W. Lowrance, *Modern Science and Human Values* (New York: Oxford University Press, 1985); Deborah Shapley and Rustum Roy, *Lost at the Frontier: U.S. Science and Technology Policy Adrift* (Philadelphia: ISI Press, 1985); Harvey A. Averch, *A Strategic Analysis of Science and Technology Policy* (Baltimore: Johns Hopkins University Press, 1985); and National Science Foundation, *Federal R&D Funding: The 1975-85 Decade* (Washington: GPO, 1984).

ductivity; (2) contribute to meeting the nation's energy, food, and resource needs; (3) promote improved public health; (4) expand the beneficial uses of space; and (5) increase understanding of the natural environment and the changes induced by society.[2]

In outlining his position on science and technology policy, President Carter told Congress in March 1979: "While science and technology alone will not solve all our domestic problems they hold the key to many aspects of the solutions. . . . We expect science and technology to find new sources of energy, to feed the world's growing population, to provide new tools for our national security."[3] The Carter White House became firmly committed to expanding Federal funding of R&D because of its belief that science and technology offered major contributions to the solution of the nation's most serious domestic and national security problems. The Administration supported this position by arguing that Federal funding of research and development represented an investment rather than merely an annual budget expense. President Carter articulated this rationale in his 1979 State of the Union message.

> Scientific research and development is an investment in the nation's future, essential for all fields, from health, agriculture, and environment to energy, space, and defense. We are enhancing the search for the causes of disease; we are undertaking research to anticipate and prevent significant environmental hazards; we are increasing research in astronomy; we will maintain our leadership in space science; and we are pushing back the frontiers in basic research for energy, defense, and other critical national needs.[4]

Perhaps the best example of the Carter Administration's emphasis on using science and technology to help alleviate domestic problems was in the area of energy. Developing a new national energy policy was one of the principal concerns of the Administration. This effort was led by the director of the White House Office of Energy Policy and Planning, James Schlesinger. Describing the nation's energy problems as "the moral equivalent of war," President Carter presented his National Energy Plan on 18 April 1977. The National Energy Act was not passed by Congress, however, until the following year. More important to the development of science policy—since the National Energy Act dealt primarily with regulatory and tax issues—was the establishment of the cabinet-level Department of Energy (DOE) in August 1977.[5] The Carter energy policy stressed the promotion of energy conservation, synthetic fuels, and solar energy, while deemphasizing nuclear power. The DOE promoted the objectives in part through an expanding R&D

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[2] See Ronayne, *Science in Government*, pp. 112–113; Barfield, *Science Policy from Ford to Reagan*, pp. 10–36; and Frank Press, "Science and Technology in the White House, 1977 to 1980: Part I," *Science*, 211 (January 9, 1981), 139–149 and "Part II" (January 16, 1981), 249–256.

[3] "Science and Technology, Message to Congress, March 27, 1979," *Public Papers of the Presidents, Jimmy Carter (1979)* (Washington: GPO, 1980), pp. 528, 531.

[4] *Public Papers . . . Carter (1979)*, p. 140. See also, "Industrial Innovation Initiatives, Message to Congress, October 31, 1979," in *Ibid.*, pp. 2070–2074; and Barfield, *Science Policy from Ford to Reagan*, p. 12.

[5] Public Law 95–91.

budget, most of it administered by DOE's Office of Energy Research.[6]

## Science Policy Under President Reagan

Like the Carter Aministration before it, the Reagan Administration believed strongly in the contributions offered to society by advances in science and technology, especially with regard to economic growth and national security. As a result, the Federal funding of research and development escaped the large budget decreases suffered by many domestic programs during the Reagan Administration.[7] This strong commitment to research was accompanied, however, by a significant shift in the Nation's science policy. Under President Reagan, the following priorities were stressed: (1) Federally funded R&D should help strengthen national defense; (2) Federally funded R&D should contribute to economic growth; (3) Federal support of science should concentrate on basic research; and (4) Federal support of applied research should be supplanted by funding from the private sector.[8]

These changes in policy were reflected in the research and development budgets for the years 1981–1985. When measured in constant dollars, Federal support for military R&D increased 65% between FY 1981 and FY 1985, while Federal funding of civilian R&D decreased 14%. Basic civilian research received a 27% increase in Federal funding during this period, while the Federal support of civilian applied R&D declined 36%.[9] Many members of the research community criticized this approach, arguing that the Federal support of R&D should be guided by the actual needs of science, not by potential economic or defense-related payoffs. Decreases in the support of civilian R&D, it was charged, was eroding the overall state of U.S. science and technology, most notably in its neglect of the research infrastructure. Cutbacks in Federal funding for the social and behavorial sciences and science education also drew the ire of some members of the research community, as did the Administration's emphasis on the physical sciences over the life sciences.[10]

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[6] See Press, "Science and Technology in the White House, 1977 to 1980. Part II," pp. 254-255; and Barfield, *Science Policy from Ford to Reagan*, pp. 19-25.

[7] For a good overview of science policy during the Reagan Administration, see Genevieve J. Knezo, "Science Policy and Funding in the Reagan Administration," Issue Brief No. IB82108 (Washington: Congressional Research Service, Library of Congress, 1984). Also useful is George A. Keyworth II, "Four Years of Reagan Science Policy: Notable Shifts in Priorities," *Science*, 224 (April 6, 1984), 9-13.

[8] See Knezo, "Science Policy and Funding in the Reagan Administration," p. 1; Christopher Joyce, "Science under Reagan: The First Four Years," *New Scientist*, No. 1440 (January 24, 1985), 24-25; and Dickson, *The New Politics of Science*, passim. For examples of issues facing science policymakers in the 1980s, see U.S. Congress, House Committee on Science and Technology, *National Science and Technology Policy Issues, 1979*, (96th Congress, 1st session. Washington: GPO, 1979); General Accounting Office, *Major Science and Technology Issues* (Washington: GPO, 1981); *Emerging Issues in Science and Technology, 1981: A Compendium of Working Papers for the National Science Foundation* (Washington: National Science Foundation, 1981); Organization for Economic Co-operation and Development, *Science and Technology Policy for the 1980s* (Paris: OECD, 1981); and Donald S. Fredrickson, "Biomedical Research in the 1980s," *New England Journal of Medicine*, 304 (February 26, 1981), 509-517.

[9] See Knezo, "Science Policy and Funding in the Reagan Administration," pp. 1–2; William C. Boesman, "U.S. Civilian and Defense Research and Development Funding: Some Trends and Comparisons with Selected Industrialized Nations," Report No. 83-183 SPR (Washington: Congressional Research Service, Library of Congress, 1983); and "Basic Research in the U.S.," *Christian Science Monitor*, 4 parts, 22-25 January 1985. See also, George A. Keyworth II, "Science and Technology Policy: The Next Four Years," *Technology Review*, 88 (February-March, 1985), 45–46, 48, 50–53.

[10] See Knezo, "Science Policy and Funding in the Reagan Administration," pp. 8–11.

## Scientific Instrumentation

The state of scientific instrumentation at the nation's research laboratories became a major science policy issue in the decade following 1975. The tightening of the Federal research budget during the preceding ten years, along with the depressed economy and high rate of inflation in the 1970s, had led scientists and research administrators alike to defer the purchase and maintenance of scientific equipment.[11] This was compounded by the fact that the cost of research equipment rose faster during the 1970s than the rate of inflation. The problem was most pronounced within the academic research sector, where the extended deficiencies in both Government and private expenditures for scientific apparatus was leading to a significant decline in "the quality of research instrumentation."[12]

The National Science Foundation responded to this concern over university research by contracting with the American Association of Universities (AAU) to conduct a comprehensive examination of research undertaken within the academy. Published in 1977 under the title *The State of Academic Science: The Universities in the Nation's Research Effort,* the report found academic science to be in substantial trouble.[13] "When federal research support grew rapidly from the late 1950s until the mid-1960s," it was explained, "science departments built a base of equipment that helped carry forward the research effort. However, the equipment acquired in that period has now begun to age and wear out in many departments."[14] The report continued:

> The drop in support for equipment may be viewed as a natural outcome of recent trends. When funds are tight, agency officials are tempted to allocate money to support essential personnel costs and to postpone acquisition of new equipment. Investigators, too, have been reluctantly willing to postpone replacement or to neglect adequate maintenance. However understandable the short-run adaptation to austerity, the long-range consequences of a deteriorating equipment base for American science are serious.[15]

The National Academy of Sciences, in its *Five-Year Outlook* published in 1979, concurred with the AAU report on the health of academic science. In providing the Executive Branch and the Congress with an assessment of the U.S. research effort, the Academy reported that:

> The federal government's decision to reduce allocations for capital investment and equipment was a rational response to budgetary problems. However, the period of low investment was so protracted that many research installa-

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[11] See National Science Foundation and National Academy of Sciences, *Survey of Research Equipment Needs in Ten Academic Disciplines* (Washington: GPO, 1972); and National Science Board, *Science Indicators, 1972* (Washington: GPO, 1973), p. 72.

[12] National Science Board, *Science Indicators, 1974* (Washington: GPO, 1975), p. 45.

[13] See Bruce L. R. Smith and Joseph J. Karlesky, *The State of Academic Science: The Universities in the Nation's Research Effort* (New York: Change Magazine Press, 1977).

[14] *Ibid.,* p. 168.

[15] *Ibid.,* p. 169.

> tions have become, or are becoming, obsolescent. Some experiments simply cannot be performed in existing facilities with an earlier generation of equipment. In short, the academic research system in consuming its capital, and the grace period during which the system could operate effectively on earlier capital investments is running out.[16]

Attention to the instrumentation issue continued to grow during the 1980s, especially among those within the academic community.[17] As the instrumentation needs of the universities expanded, some academic institutions began bypassing the peer review process in their attempts to secure large instrument and facility grants from the Federal Government. Several controversies were ignited within the scientific community when research funding requests were taken directly to the floor of Congress in the form of amendments to appropriations bills.[18] Examples of new research centers funded by Congress in the 98th Congress without the normal peer review process included an engineering center at Boston University, a vitreous-state facility at the Catholic University of America, a technology-transfer center at Northwestern University, an advanced chemistry facility at Columbia University, and a science center at the University of Oregon.[19] Concerned with this trend, the governing council of the National Academy of Sciences passed a resolution at its October 1983 meeting which called "upon the academic community and public officials to use the time-honored peer review system in the evaluation of funding proposals for federally funded research facilities and large scientific instruments." [20]

### Congress and Science Policy

Following the passage of the National Science and Technology Policy, Organization, and Priorities Act of 1976, Congress maintained a high interest in the development of science and technology policies. As Congressional concerns over the health of the nation's research effort grew, Representative Don Fuqua, Democrat of Florida and Chairman of the House Committee on Science and Technology, decided to initiate a major study of the nation's science policy. In July 1984, he created an 18-member bipartisan Task Force on Science Policy within the Committee on Science and Technology. Three formal planning meetings were held in August and September where Members decided what issues would be addressed in the

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[16] National Academy of Sciences, *Science and Technology: A Five-Year Outlook* (San Francisco: W. H. Freeman and Co., 1979), p. 481.

[17] See, for example, Association of American Universities, *The Scientific Instrumentation Needs of Research Universities: A Report to the National Science Foundation* (Washington: 1980); Association of American Universities, *The Nation's Deteriorating University Research Facilities: A Survey of Recent Expenditures and Projects Needs in Fifteen Universities* (Washington: 1981); Association of American Universities, et al., *Financing and Managing University Research Equipment (Washington: 1985);* and U.S. Congress, House Committee on Science and Technology, *Improving the Research Infrastructure at U.S. Universities and Colleges* (98th Congress, 2nd session, Washington: GOP, 1984).

[18] See Howard J. Sanders, "Peer Review: How Well Is It Working?," *Chemical & Engineering News*, 60 (March 15, 1982), 32–43; and Donald Kennedy, "Government Policies and the Cost of Doing Research," *Science*, 227 (February 1, 1985), 480–484.

[19] See Kim McDonald, "U.S. Science Officials Ask Congress to Stop Bypassing Peer Review of Research Grants," *Chronicle of Higher Education*, 29 (October 3, 1984), 13.

[20] "Peer Review of Large Instrument Grants," (National Academy of Sciences) *News Report*, 33 (December 1983), 13.

two-year science policy study to be undertaken during the 99th Congress.[21] Only the Bush and Steelman reports of the mid-1940s and the Elliott and Daddario reports of the mid-1960s matched the comprehensive scope of the proposed Task Force study. According to the Task Force's *Agenda:*

> The last major Congressional review of American science policy took place in the mid-sixties, almost twenty years ago. Since that time, the relationship between science and government has undergone a number of significant changes, and there is every indication that further changes in that relationship are in prospect. In addition, the wider environment in which both government and science must function is expected to change in ways that will affect both science and the science-government relationship.
>
> It is therefore timely that the Science and Technology Committee conduct a careful review of American science policy. Such a review will enable the members of the Committee, and the wider membership of the House of Representatives, to discharge their legislative and oversight responsibilities on the basis of a deeper understanding of past policies, present problems, and future needs and choices.[22]

The broad agenda established by the Science Policy Task Force reflected the wide range of issues that faced science policymakers in the 1980s. Many of these issues had, of course, been debated, in one form or another, since 1945. The quality of science education, especially at the post-secondary levels, and how it relates to the future workforce of scientists and engineers had been an issue outlined in the Bush Report and recurred in the aftermath of *Sputnik.* International cooperation became an issue again in the 1980s during discussions of sharing resources, both monetary and facilities, for such "Big Science" projects as particle accelerators and astronomical observatories. The growing concern over the state of research facilities at university and Government laboratories was closely linked to the ongoing scientific instrumentation question. As Government regulation for health and safety increased—much of it justified by new scientific data on risk or hazards—the scientific community became involved in the regulatory system and many researchers began to question the criteria for the use of science and technical experts in regulation. The growth in Government controls over the conduct and dissemination of research raised, in often a confrontational manner, issues of self-regulation and the role of the public in research that had been hinted at in the Bush and Steelman reports. And finally, debates over the expansion of large-scale university-industry cooperation brought to the forefront issues that had surfaced decades before.[23]

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[21] See U.S. Congress, House Committee on Science and Technology, Task Force on Science Policy, *An Agenda for a Study of Government Science Policy* (98th Congress, 2nd session. Washington: GPO, 1985).

[22] *Ibid.*, p. 1.

[23] See *ibid.;* U.S. Congress, House Committee on Science and Technology, Subcommittee on Science, Research and Technology, *Impact of National Security Considerations on Science and*

Continued

## Summary

Between 1975 and 1985, science policy in the United States increasingly stressed the importance of Federal support for basic research. Declines in the growth rate for Government R&D expenditures characteristic of the previous ten years were replaced by an upswing in Federal science budgets. Throughout this period, commitment to the principles of pluralism in the support of science remained strong, although President Reagan's Commission on Industrial Competitiveness recommended in 1984 that this system be given greater central coordination through the establishment of a Department of Science and Technology.[24] Both the Carter and Reagan Administrations shared the same fundamental rationale for the Federal support of research and development—that being that such expenditures provide significant contributions to the economic welfare and national security of the country. This, as we have seen, was the same basic rationale promoted in the 1940s by Vannevar Bush.

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*Technology* (97th Congress, 2nd session. Washington: GPO, 1982); Office of Technology Assessment, *The Regulatory Environment for Science: A Technical Memorandum* (Washington: GPO, 1986); Office of Technology Assessment, *Demographic Trends and the Scientific and Engineering Work Force: A Technical Memorandum* (Washington: GPO, 1985); National Academy of Sciences, *Reducing Bureaucratic Accretion in Government and University Procedures for Sponsoring Research* (Washington: National Academy of Sciences, 1986); National Science Board, *University-Industry Research Relationships: Myths, Realities and Potentials* (Washington: GPO, 1982); and Dickson, *The New Politics of Science.*

[24] For the Reagan Administration's interest in establishing a cabinet-level Department of Science and Technology, see "White House and Science: Idea of Cabinet Department Revived," *Chemical & Engineering News,* 62 (November 19, 1984), 6–7: "Presidential Commission Seeks Department of Science," *Science and Government Report,* 14 (December 1, 1984), 1–5; William J. Broad, "Science Department in Cabinet Is Urged," *New York Times,* 11 December 1984; and Michael E. Davey, Christopher T. Hill, and Wendy H. Schacht, *Establishing a Department of Science and Technology; An Analysis of the Proposal of the President's Commission on Industrial Competitiveness,* Report No. 85–122 SPR (Washington: Congressional Research Service, Library of Congress, 1985).

# APPENDIX

## CHRONOLOGY OF FEDERAL SCIENCE POLICY DEVELOPMENTS, 1787-1985

The following chronology traces the evolution of Federal concern with developments in the field of science and technology. It emphasizes to some extent legislative actions and organizational matters. The following criteria were used to select items to include in the chronology: 1. The item deals with a significant hearing or study that focused on Federal organization for science and technology, 2. The item consists of a legislative proposal on Federal organization for science and technology, 3. The item involves the passage of a new public law or the amendment of an existing public law relating to Federal organization for science and technology, 4. The item proposed a new agency or the reorganization of an existing scientific agency, 5. The item consists of an Executive Order that would affect Federal Organization for science and technology, or 6. The item involves the appointment of a Presidential nominee.

1787: The Constitutional Convention considered scientific and technical matters to be included in the Constitution. Among the ideas discussed were the establishment of national seminaries and universities for the promotion of literature, the arts, and the sciences; charters of incorporation for national societies and institutions dedicated to the advancement of knowledge; and the establishment of public institutions, rewards, and subsidies to promote agriculture, commerce, and the advancement of useful knowledge and discovery.

1787: Science in the Constitution. The only specific reference to "science" in the Constitution is in Article I, Section 8: "The Congress shall have Power * * * To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries".

April 10, 1790: First patent act passed at request of President Washington. Secretaries of State, War and the Attorney General constituted a board to pass on inventions. Keeping records made responsibility of Secretary of State. (Act of April 10, 1790; 1 Stat. 109)

April 2, 1792: The United States Mint was established by Congress. (Act of April 2, 1792; 1 Stat. 246)

February 18, 1793: New patent act put Secretary of State in charge of patents. (1 Stat. 318)

July 16, 1798: Provision of medical care for merchant seamen by the Federal Government was authorized by Congress. Treasury

Department was given administrative responsibility. The first marine hospital constructed with Federal funds was completed in 1800.

The U.S. Public Health Service traces its beginning to these hospitals. (1 Stat. 605)

April 24, 1800: Library of Congress was established by law approved April 24, 1800. (2 Stat. 56)

February 10, 1807: Coast Survey established under administrative direction of the Secretary of the Treasury by Act of Congress. (Act of February 10, 1807; 2 Stat. 413)

February 19, 1818: Surgeon General's Office and the Army Medical Department established with authority to prevent and treat disease and to collect weather data for processing and analysis. (3 Stat. 408)

1830: Secretary of the Navy established a Depot of Charts and Instruments, which later evolved into the Naval Observatory.

June 14, 1836: Secretary of the Treasury was directed to cause a complete set of all the weights and measures adopted as standards to be delivered to the Governor of each State for the use of the States. (Resolution No. 7; 5 Stat. 133)

July 4, 1836: Permanent office of commissioner of patents created. (Act of July 4, 1836; (5 Stat. 117)

August 31, 1842: By act of Congress a sum of $25,000 was authorized for a building for the Navy Depot of Charts and Instruments, later the Naval Observatory.

August 10, 1846: The Smithsonian Institution was chartered by Congress. Initial endowment came from gift of $500,000 from James Smithson in 1829. (9 Stat. 103)

March 3, 1849: Department of the Interior was established, taking over the General Land Office from the Treasury Department, the Office of Indian Affairs from the War Department, and the Pension Office and the Patent Office, which had been independent offices. (9 Stat. 395)

May 15, 1862: U.S. Department of Agriculture established. Among its missions was the systematic application of scientific methods to agriculture. The department was elevated to Cabinet status in 1889. (12 Stat. 387, ch. 72)

July 2, 1862: Morrill Act or Land Grant College Act passed providing for establishment in each state of at least one college to provide instruction in agriculture and the mechanic arts. The significance of the act was that it formally recognized the national need for trained manpower in selected fields, and established mechanisms for cooperative Federal and state government participation in financing academic activities related to science and research interests. (12 Stat. 503)

March 3, 1863: National Academy of Sciences was established by Congressional charter. (12 Stat. 806)

March 2, 1867: Office of Education was established. (14 Stat. 434)

1869: Office of Education became a part of the Department of the Interior.

July 8, 1870: Further general revision of the patent laws. (16 Stat. 198)

December 18, 1884: Joint resolution extending the time fixed for the joint commission (Allison Commission) appointed under the

sundry civil act approved July 7, 1884, to consider present organizations of Signal Service, Geological Survey, Coast and Geodetic Survey, and Hydrographic Office of the Navy Department to secure greater efficiency and economy, to submit their report. (Joint resolution No. 1, 23 Stat. 515)

June 20, 1878: Coast Survey redesignated Coast and Geodetic Survey (20 Stat. 206, 215)

March 3, 1879: U.S. Geological Survey was established (20 Stat. 394; 43 U.S.C. 31) within the Department of the Interior. The broad objectives of USGS are to perform surveys, investigations, and research covering topography, geology, and the mineral and water resources of the U.S.: classify land as to mineral character and water and power resources; enforce departmental regulations applicable to oil, gas, and other mining leases, permits, licenses, development contracts, and gas storage contracts; and publish and desseminate data relative to these activities.

March 2, 1887: Hatch Act of 1887 further encouraged scientific agriculture by providing for agricultural experiment stations in the land-grant colleges. (24 Stat. 440)

October 1, 1890: Weather Bureau established within the Department of Agriculture. (26 Stat. 653)

March 2, 1901: Appropriations for the Department of Agriculture for fiscal year 1902 made separate appropriations for the Bureau of Chemistry, Bureau of Plant Industry, and Bureau of Soils, thereby establishing them as separate and independent bureaus. (31 Stat. 922)

March 3, 1901: National Bureau of Standards established in Department of the Treasury, replacing the Office of Construction of Standard Weights and Measures. The new bureau was given full powers over custody, preparation, and testing of standards and responsibilities for "the solution of problems which arise in connection with standards * * *." In addition to service to Federal state and municipal governments, the bureau was to provide for a fee standards for nongovernmental units or individuals.

The legislation was an indication of the renewed willingness and ability of Congress to provide an administrative means of dealing with government science needs. [On February 14, 1903 the bureau became part of the new Department of Commerce and Labor. Public Law 87: 32 Stat. 825] (31 Stat. 1449)

March 6, 1902: Bureau of the Census was established in the Department of Interior, giving permanency to an organization for the census in perference to the previous temporary organization set up every ten years and subsequently allowed to lapse. (Public Law 27; 32 Stat. 51)

July 1, 1902: A bill to increase the efficiency and change the name of the Marine Hospital Service to Public Health and Marine Hospital Service was enacted. The law authorized the establishment of specified administrative divisions, and, for the first time, designated a bureau of the Federal Government as an agency in which public health matters could be coordinated. (32 Stat. L. 712)

January 12, 1903: Secretary of the Interior was directed to transfer all census records and volumes to the Census Office. (Public Law

20; 32 Stat. 767) [Census office was transferred to Department of Commerce and Labor by act of February 14, 1903.]

February 14, 1903: Department of Commerce and Labor created by act of Congress. Section 12 authorized the President to transfer to the new department at any time all or part of any unit engaged in "statitistical or scientific work" from the Departments of State, Treasury, War, Justice, Post Office, Navy, and Interior. (Public Law 87; 32 Stat. 825)

1903: A Committee on Organization of Scientific Work was appointed by President Theodore Roosevelt to consider the central organization of government scientific bureaus with primary emphasis on eliminating duplication. During the four months of its existence the Committee prepared a series of reports on individual government bureaus.

April 28, 1904: An act to incorporate the Carnegie Institution of Washington. The objects of the corporation "shall be to encourage * * * investigation, research, and discovery, and the application of knowledge to the improvement of mankind." (Public Law 260; 33 Stat. 575)

February 1, 1905: Transfer of forest reserves from Department of the Interior to Department of Agriculture; change of name of Division of Forestry to Forest Service. (Public Law 35; 33 Stat. 628)

March 16, 1906: The Adams Act of 1906 strengthened both financial support for agricultural experiment stations and their control by the Federal government, increasing annual funding but also restricting use of funds to "conducting original researches or experiments bearing directly on the agricultural industry of the United States." (Public Law 47; 34 Stat. 63)

April 23, 1908: A reorganization of the Medical Department of the U.S. Army providing for a Medical Corps and Medical Reserve Corps as well as the existing Hospital corps, nurse corps and dental surgeons. (Public Law 101; 35 Stat. 66)

May 16, 1910: Bureau of Mines established in the Department of the Interior. The principal duties of the bureau related to ways to improve conditions and safety in mines.

Functions authorized to be transferred from the U.S. Geological Survey related to investigations of structural materials, analyses of fuel substances (coal, lignites and other mineral fuels), and investigation of causes of mine explosions. (Public Law 179; 36 Stat. 369)

August 14, 1912: Under an act, the name Public Health and Marine Hospital Service was changed to Public Health Service. The legislation also authorized the Public Health Service to conduct field investigations and studies and, in particular, investigations of the diseases of man and pollution of navigable streams. The significance of this legislation was that by opening the whole field of public health to research by the government, it was recognized as a legitimate area of Federal activity. (Public Law 265: 37 Stat. 309)

February 25, 1913: By a new organic act the field of the Bureau of Mines was expanded by definition to include "Mining, metallurgy, and mineral technology," thus extending the activities beyond the coal industry and for prevention of waste as well as mine safety. (Public Law 386; 37 Stat. 681)

March 4, 1913: Department of Commerce and Labor separated by act of Congress which created a new Department of Labor. (Public Law 426; 37 Stat. 736)

May 8, 1914: The Smith-Lever Act provided for cooperative agricultural extension work between the agricultural colleges receiving benefits under the Act of July 2, 1862 (the Morrill Act). Cooperative agricultural extension work (home and field demonstration) was also authorized for people not in the colleges. By this act the Extension Service of the Department of Agriculture was put on a separate and permanent basis. (Public Law 95; 38 Stat. 372)

March 3, 1915: The Advisory Committee for Aeronautics (later the National Advisory Committee for Aeronautics, or NACA) was established by a rider to the Naval Appropriations Act, "* * * to supervise and direct the scientific study of the problems of flight, with a view of their practical solution." The sum of $5,000 a year was appropriated for 5 years. The total appropriation for naval aeronautics was $1 million. NACA was the first war research agency of the World War I period. (Public Law 271; Stat. 928)

July 1915: A Naval Consulting Board with Thomas A. Edison, chairman, was appointed by Navy Secretary Josephus Daniels. The Board whose membership was selected from the eleven largest engineering societies in the U.S. was intended to serve as a review and evaluation board for ideas and suggestions which might be developed for defense purposes.

1916: A National Research Council of the National Academy of Sciences was established to permit a larger part of the scientific community to assist in research in connection with national preparedness. Approval of the Council by a letter of July 25, 1916 from President Woodrow Wilson to the President of the NAS was formalized by the issuance of Executive Order 2859 of May 11, 1918.

August 25, 1916: National Park Service was established in the Department of Interior. National parks, monuments and reservations were placed under the supervision of the director who was responsible to the Secretary. (Public Law 235; 39 Stat. 535)

February 23, 1917: Smith-Hughes Act created a Federal Board of Vocational Education for promotion of vocational education in cooperation with the states. Appropriated funds for the training and salaries of teachers of trade, home economics, and industrial subjects. (Public Law 347; 39 Stat. 929)

October 1, 1917: Congress created the Aircraft Board to expand and coordinate the industrial activities relating to aircraft and to facilitate generally the development of air service. (Public Law 48: 40 Stat. 296)

October 27, 1918: A joint resolution establishing a Reserve Corps for the Public Health Service was passed. The 1918 influenza epidemic emphasized the need for a reserve corps in the Service to meet such emergency situations. (Public Resolution 45; 40 Stat. 1017)

June 10, 1920: Federal Power Commission was created to provide for the improvement of navigation, the development of water power, and use of public lands in relation thereto. The Commission was authorized to make investigations and collect data on the utilization of water resources, and on the water power indus-

try. (Public Law 280; 41 Stat. 1063). (Amended to prohibit power projects in national parks or monuments unless specifically authorized by Congress: Public Law 369, March 3, 1921; 41 Stat. 1353)

June 10, 1921: Budget and Accounting Act, 1921. Established the Bureau of the Budget, provided for the annual submission of a consolidated Federal budget, and established a General Accounting Office. Henceforth, all Federal agency fund requests including research would have to receive central approval prior to transmission to Congress. (Public Law 13; 42 Stat. 20)

May 11, 1922: The appropriations act of the Department of Agriculture for fiscal year 1923 authorized the creation of the Bureau of Agricultural Economics out of miscellaneous already existing statistical and analytical activities. This has been cited as an example of the type of new social-science agencies which were created during the 1920's. (Public Law 217; 42 Stat. 531)

February 26, 1923: Bureau of Home Economics established in the Department of Agruculture by appropriations act for the department for fiscal year 1924. (Public Law 446; 42 Stat. 1315)

1923: Naval Research Laboratory was established. Its legislative basis goes back to initial sums appropriated in 1916 for a laboratory for the Naval Consulting Board.

February 24, 1925: The Purnell Act authorized additional funds to be appropriated for each agricultural experiment station for fiscal years 1926 and thereafter according to a graduated scale. Funds were to be used for necessary expenses of investigations relating to agricultural products including scientific researches on the "establishment and maintenance of a permanent and efficient agricultural industry." (Public Law 458; 43 Stat. 970)

April 13, 1926: An act amending the Morrill Act of 1862 to provide for investment of proceeds from public land sales, the establishment of a perpetual fund, and use of interest from the fund to be applied toward endowment for maintenance of colleges specializing in agriculture and mechanics, "without excluding other scientific classical studies." (Public Law 113; 44 Stat. 247)

May 20, 1926: Air Commerce Act, 1926. This was the first Federal legislation regulating civil aeronautics. Gave the Department of Commerce wide powers over aviation. Research and development to improve air navigation facilities was specifically mentioned among the ways in which Congress directed the Secretary of Commerce to foster air commerce. He was also directed to make recommendations to the Secretary of Agriculture concerning necessary meteorological service. (Public Law 254; 44 Stat. 568)

February 23, 1927: Radio Act of 1927. Created a Federal Radio Commission to be responsible for the regulation and control of radio transmission within the United States and of channels of interstate and foreign radio transmission. (Public Law 632; 44 Stat. 1162)

March 2, 1927: Amendments to the patent laws. Provided that examiners in chief shall have competent legal or scientific ability. Amended the appeals procedure. (Public Law 690; 44 Stat. 1335)

March 10, 1928: Authorized $900,000 to complete transfer of experimental and testing plant of Air Corps to a permanent site at

Wright Field, Dayton, Ohio and for construction and installation of technical buildings. (Public Law 150; 45 Stat. 299)

April 30, 1928: Amendment to patent laws permitting issuing of patents to Government employees without fee when the invention is certified to be in the public interest: Inventions so patented must be made available for Government manufacture or use without payment of royalty. (Public Law 325; 45 Stat. 467)

May 22, 1928: Further amendment to Morrill Act of 1862 to authorize additional appropriations for cooperative extension work in agriculture and home economics. (Public Law 475; 45 Stat. 711)

January 19, 1929: The Narcotics Control Act provided for construction of two hospitals for the care and treatment of drug addicts, and authorized creation of a Narcotics Division in the Office of the Surgeon General of the Public Health Service. (Public Law 70-672; 45 Stat. L. 1085)

February 23, 1929: Benefits of the Hatch Act and the Smith-Lever Act relating to cooperative extension work between agricultural colleges were extended to the Territory of Alaska. (Public Law 797; 45 Stat. 1256)

March 2, 1929: Membership of the National Advisory Committee for Aeronautics increased from 12 to 25 members by act of Congress. (Public Law 908; 45 Stat. 1451)

April 9, 1930: The act provided for detail of Public Health Officers or employees to other departments or agencies to cooperate in public health activities. The act also changed the name of the advisory board for the Hygienic Laboratory to the National Advisory Council. (Public Law 106; 46 Stat. 150)

May 14, 1930: An act to authorize the establishment of a national hydraulic laboratory in the Bureau of Standards. (Public Law 219; 46 Stat. 327)

May 23, 1930: An act to provide for plant patents. (Public Law 245; 46 Stat. 376)

May 26, 1930: The Randsell Act reorganized, expanded, and redesignated the Hygienic Laboratory as the National Institutes of Health. The act authorized $750,000 for the construction of two buildings for NIH and authorized the establishment of a system of fellowships. (Public Law 71-251; 46 Stat. L. 379)

June 11, 1930: An act to provide for the modernization of the U.S. Naval Observatory at Washington, D.C. (Public Law 343; 46 Stat. 556)

June 14, 1930: A law authorized creation of a separate Bureau of Narcotics in the Treasury Department to control trading in and use of narcotic drugs for therapeutic purposes. Also, the legislation changed the name of the Narcotics Division of the Public Health Service to the Division of Mental Hygiene, and gave the Surgeon General authority to investigate the causes, treatment, and prevention of mental and nervous diseases. (Public Law 71-357; 46 Stat. L. 585)

Feburary 20, 1931: An act to authorize the Secretary of Commerce to purchase land and to construct buildings and facilities for radio research investigations. (Public Law 700; 46 Stat. 1196)

March 4, 1931: The Director of the Census was directed to collect and publish crime statistics. (Public Law 837; 46 Stat. 1517)

May 18, 1933: Tennessee Valley Authority Act of 1933. Created a Tennessee Valley Authority (TVA) to maintain and operate a power plant at Muscle Shoals, Alabama. Other objectives of the act were to improve navigability on and provide flood control of the Tennessee River, to improve surrounding lands and provide for agricultural and industrial development of the Tennessee Valley. (Public Law 17; 48 Stat. 58)

July 31, 1933: Science Advisory Board under the National Research Council was created by President Roosevelt by Executive Order 6238. The Executive Order authorized the Board, acting through the machinery and under the jurisdiction of the NAS–NRC, "to appoint committees to deal with specific problems in the various departments."

June 19, 1934: Communications Act of 1934. Created a Federal Communications Commission to regulate Interstate and foreign commerce communication by wire or radio. Title III provided for licenses for radio communication. The Act also gave the President ware emergency power to direct communications. (Public Law 416; 48 Stat. 1064)

June 30, 1934: National Resources Board established by Executive Order 6777. The Board was later designated the National Resources Committee (Executive Order 7065, June 7, 1935) and then the National Resources Planning Board (July 1, 1939). A principal activity of the Board was the preparation of a three-volume study entitled "Research—A National Resource."

January 22, 1935: Federal Aviation Commission, appointed by the President as provided in the Air Mail Act of June 12, 1934, submitted its report and set forth broad policy on all phases of aviation and the relation of Government thereto. It recommended strengthening of commercial and civil aviation, expansion of airport facilities, and establishment of more realistic procurement practices from industry. It recommended continued study of air organization toward more effective utilization and closer interagency relationships, to include expansion of experimental and development work and its close coordination with the NACA.

April 27, 1935: The Department of Agriculture was directed to establish a Soil Conservation Service to provide for the protection of land resources against soil erosion through research, preventive measures, cooperative arrangements, and land acquisition where necessary. (Public Law 46; 49 Stat. 163)

June 29, 1935: Bankhead-Jones Act provided for the expansion of scientific, technical, economic and other research into the laws and principles underlying basic problems in agriculture. By appropriating funds for basic research, Congress recognized that its value may exceed that of research on specific problems.

Department of Agriculture implementation of the program authorized by this act led to the establishment of regional laboratories located according to problems of that area. (Public Law 182; 49 Stat. 436)

August 14, 1935: The Social Security Act was an event of major importance in the progress of public health in the United States. This act authorized health grants to the States on the principle that the most effective way to prevent the interstate spread of disease is to improve State and local public health programs.

With this legislation, the Public Health Service became adviser and practical assistant to State and local services. (Public Law 74-271; 49 Stat. L. 634)

December 1935: Science Advisory Board transferred to Committee on Government Relations of NAS which was renamed the Government Relations and Science Advisory Committee. The Committee was discontinued in Oct. 1939.

May 6, 1936: Construction authorized for what later was named the David W. Taylor Model Basin, to provide a facility for use of the Navy Bureau of Construction and Repair in investigating and determining shapes and forms to be adopted for U.S. naval vessels, and including aircraft. (Public Law 568; 49 Stat. 1263)

May 20, 1936: Rural Electrification Act of 1936 established a Rural Electrification Administration to make loans to states to extend electric power to rural areas and to make and publish studies concerning the progress of the program. (Public Law 605; 49 Stat. 1363)

August 5, 1937: A law established the National Cancer Institute to conduct and support research relating to the cause, diagnosis, and treatment of cancer. The law authorized the Surgeon General to make grants-in-aid for research projects in the field of cancer, provide fellowships, train personnel, and assist the States in their efforts toward cancer prevention and control. (Public Law 75-244; 50 Stat. L. 559)

February 16, 1938: Agricultural Adjustment Act of 1938 declared it to be the policy of Congress to conserve and improve the nation's soil resources; to regulate commerce in cotton, wheat, corn, tobacco, and rice to assure a balanced flow, and to bring about "parity prices" and "parity income" for agricultural producers. The act authorized funds to establish and maintain laboratories to conduct research on the industrial utilization of agricultural products. One of four regional research laboratories thus established later became famous for its role in developing mass production of penicillin. (Public Law 430; 52 Stat. 31)

June 23, 1938: Civil Aeronautics Act of 1938 coordinated all nonmilitary aviation under a new Civil Aeronautics Authority. An Air Safety Board was established to investigate and report on accidents and make recommendations for accident prevention. (Public Law 706; 52 Stat. 973)

April 3, 1939: The Reorganization Act of 1939 transferred the Public Health Service from the U.S. Treasury Department to the Federal Security Agency. (Public Law 361; 53 Stat. 1306)

July 1, 1939: Federal Security Agency created, grouping under one administration those agencies whose major purposes were to promote social and economic security, educational opportunity, and health of the citizens of the Nation; namely, Office of Education, Public Health Service, Social Security Board, U.S. Employment Service, Civilian Conservation Corps, and National Youth Administration. (Reorganization Plan I, effective this date)

August 9, 1939: Congress authorized construction of second NACA research station at Moffett Field, Calif., which became the Ames Aeronautical Laboratory. (Public Law 361; 53 Stat. 1306)

June 26, 1940: Congress authorized construction of the third NACA Laboratory near Cleveland, Ohio, which became Aircraft Engine

Research Laboratory. In 1948, it was named for George W. Lewis, NACA Director of Aeronautical Research, 1924–47. (Public Law 667; 54 Stat. 599)

July 31, 1940: A joint resolution appropriating $25 million for fiscal year 1941 to the Tennessee Valley Authority for facilities needed for the national defense. (Public Law 95; 54 Stat. 781)

May 7, 1941: An act providing for annual inspections of coal mines by the Secretary of the Interior acting through the U.S. Bureau of Mines to assure health and safety conditions, to determine basis for expenditure of public funds toward this goal or for educational materials and to obtain information for Congress on accidents, occupational diseases and other matters for legislative action. (Public Law 49; 55 Stat. 177)

June 28, 1941: Office of Scientific Research and Development (OSRD) in the Office of Emergency Management was created by President Roosevelt by Executive Order 8807.

July 16, 1941: A joint resolution appropriating an additional sum of $40 million for the Tennessee Valley Fund for fiscal year 1942.

August 21, 1941: An act prohibiting foreign patenting of an invention made in the United States, except when licensed to do so by the Commissioner of Patents. (Public Law 239; 55 Stat. 657)

September 24, 1941: An act authorizing funds for construction of an Army Medical Library and Museum in the District of Columbia. (Public Law 256; 55 Stat. 731)

October 31, 1942: An act giving the Government power to fix royalties for the use of inventions needed in the prosecution of the war. (Public Law 768; 56 Stat. 1013)

April 16, 1943: Female physicians and surgeons in the Medical Corps of the Army and Navy were authorized by this Act. Persons so appointed were commissioned in Army or the Naval Reserve. (Public Law 38; 57 Stat. 65)

July 12, 1943: A Pharmacy Corps was established in the Medical Department of the Army. (Public Law 130; 57 Stat. 430)

November 11, 1943: Public Health Service Act of 1943. Set forth the organization and structure of the Public Health Service, including provisions for its operation in time of war and the effect of the war upon commissioned officers of the corps. (Public Law 184; 57 Stat. 587) (This act was repealed by a more comprehensive act of July 1, 1944)

April 5, 1944: The Secretary of the Interior through the Bureau of Mines was authorized to construct and operate demonstration plants to produce synthetic liquid fuels from coal, oil shales, agricultural and forestry products and other substances, for wartime needs. In this connection the Secretary of Interior was authorized to conduct laboratory research and development work. To acquire patent rights, to contract for plant construction and operations, to cooperate with other public or private agencies toward this end, and to sell the products of the plants at cost with priority to Federal and State agencies. (Public Law 290; 58 Stat. 190)

July 1, 1944: The Public Health Service Act consolidated and revised laws pertaining to the Public Health Service and divided the Service into the Office of the Surgeon General, Bureau of Medical Services, Bureau of State Services, and the National Institute of Health. The act gave the Surgeon General broad

powers to conduct and support research into the diseases and disabilities of man, authorized projects and fellowships, and made the National Cancer Institute a division of NIH. The act also empowered the Surgeon General to treat at Public Health Service medical facilities, for purposes of study, persons not otherwise eligible for such treatment. (Public Law 78–410; 58 Stat. L. 682) Under this provision, the Clinical Center was later established.

September 21, 1944: Department of Agriculture Organic Act of 1944 consolidated the department's functions with respect to eradication and control of animal and the plant pests and diseases, fire control, national forest management, soil conservation, and operation of the Farm Credit Administration and the Rural Electrification Administration. (Public Law 425–58 Stat. 734)

April 25, 1945: Supplemental appropriation passed by Congress authorized expanded research on guided missiles at NACA Langely Laboratory, including establishment of a rocket launch facility at Wallops Island, Va. (Public Law 40; 59 Stat. 82)

June 6, 1945: The Bankhead-Flannagan Act provided for expansion of county extension work. The act amended an earlier act of June 29, 1935 which provided for research into basic laws and principles relating to agriculture, for the further development of cooperative agricultural extension work and the more complete endowment and support of land-grant colleges. (Public Law 76; 59 Stat. 231)

July 5, 1945: Dr. Vannevar Bush, Director, Office of Scientific Research and Development, submitted report, "Science, the Endless Frontier" to President Truman covering all aspects of the study of post-war science which President Roosevelt had requested him to make in November 1944.

A principal recommendation of the report was for the establishment of a National Research Foundation, responsible to the President and to Congress, "to develop and promote a national policy for scientific research and scientific research and scientific education" and for other purposes.

July 3, 1946: The National Mental Health Act was designed to improve the mental health of U.S. citizens through research into the causes, diagnosis, and treatment of psychiatric disorders. It authorized the Surgeon General to support research, training, and assistance to State mental health programs. (Public Law 79–487; 60 Stat. L. 421) (The National Institute of Mental Health was established under the authority of this law on April 1, 1949.)

July 15, 1946: Reorganization Plan No. 2, effective this date, transferred to the Federal Security Agency (the predecessor of HEW), a number of activities relating to education, health, welfare and social insurance. The Social Security Board was abolished and its functions were transferred to the Federal Security Administrator.

August 1. 1946: Atomic Energy Act of 1946 established the Atomic Energy Commission to be the exclusive owner of all facilities for the production of fissionable materials, and of all fissionable material produced. The Commission was made responsible for research and production of atomic energy for military purposes. All patents relating to fissionable materials were to be filed with the Commission.

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The act also established the Joint Committee on Atomic Energy, the only joint congressional committee with substantive oversight powers. (Public Law 585; 60 Stat. 755)

August 1, 1946: Vocational Education Act of 1946 was a revision of the earlier act of June 8, 1936. Authorized annual appropriations of Federal aid funds to the States for training in agriculture, home economics, trades and industry and distributive occupations. Also appropriated an annual sum to the Office of Education for studies and investigations in the field. (Public Law 586; 60 Stat. 775)

August 1, 1946: An act to establish an Office of Naval Research in the Department of the Navy; to plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security; to provide within the Department of the Navy a single office, which, by contract and otherwise, shall be able to obtain, coordinate, and make available to all bureaus and activities of the Department of the Navy, world-wide scientific information and the necessary services for conducting specialized and imaginative research, to establish a Naval Research Advisory Committee consisting of persons preeminent in the fields of science and research, to consult with and advise the Chief of such Office in matters pertaining to research. (Public Law 588; 60 Stat. 779)

August 2, 1946: Legislative Reorganization Act of 1946 redefined the standing committees of the Senate and House of Representatives, and enumerated the jurisdictions of each committee. The act also established an enlarged and continuing separate department of the Library of Congress, the Legislative Reference Service.

August 12, 1946: National Air Museum was established under the Smithsonian Insitution by act of Congress. (Public Law 722; 60 Stat. 997)

October 17, 1946: By E.O. 9791, President Truman established a Presidential Scientific Research Board under Dr. John R. Steelman, Director of War Mobilization and Reconversion, in the Executive Office of the President, to investigate and report on the entire scientific program of the Federal Government with recommendations for providing coordination and improving efficency of Federal research and development.

April 16, 1947: Army-Navy Nurses Act. Established a permanent Nurse Corps. in th Army and Navy and a Women's Medical Specialist Corps in the Army Medical Department. (Public Law 36; 61 Stat. 41)

July 7, 1947: A Commission on Organization of the Executive Branch of the Government (First Hoover Commission) was established. One of the areas which it examined and reported on was Federal research. (Public Law 162; 61 Stat. 246)

July 27, 1947: S. 526, to establish a National Science Foundation, received final approval by Congress on this date. It was vetoed by President Truman on August 6, 1947, principally because of disagreement over the administrative structure of the proposed Foundation. Congressional action on this bill culminated two

years of work since the first bills to create a National Science Foundation were introduced on July 19, 1945.

July 30, 1947: A temporary Congressional Aviation Policy Board was established to survey and report on the development of a national aviation policy adequate for national defense, interstate and foreign commerce, and postal service needs. (Public Law 287; 61 Stat. 676) (The Board submitted its findings in Senate Report 949 of March 1, 1948)

August 5, 1947: Army-Navy Public Health Service Medical Officer Procurement Act of 1947. Provided additional inducements to physicians, surgeons and dentists to make a career of U.S. military, naval or public health services. (Public Law 365; 61 Stat. 776)

August 6, 1947: By act of Congress, the duties and functions of the Coast and Geodetic Survey were consolidated.

August 6, 1947: President Truman vetoed S. 526, the first bill passed by Congress to establish a National Science Foundation and an Interdepartmental Committee on Science on the grounds that the proposed organizational structure would make it impossible for him to assure proper administration.

September–October 1947: The 5-vol. Steelman report entitled "Science and Public Policy" was issued. With respect to Executive Office science organization the report recommended that the President designate a member of the White House staff for scientific liaison, that the Bureau of the Budget set up a unit for reviewing Federal scientific research and development programs, and that an Interdepartmental Committee for Scientific Research be created.

December 24, 1947: Interdepartmental Committee on Scientific Research and Development established by E.O. 9912. Presidential assistant Dr. John R. Steelman, was designated to provide liaison between the President and the committee and between the Office of the President and the scientific community.

December 31, 1947: Office of Scientific Research and Development in the Executive Office of the President was terminated and remaining personnel, records, and property were transferred to the National Military Establishment. OSRD created in 1941, in the Office for Emergency Management, had under Director Vannevar Bush served as a high-level coordinating body for scientific research and medical problems related to national defense during World War II.

April 24, 1948: Secretary of Agriculture is authorized to establish research laboratories for research and study of foot-and-mouth disease or other animal diseases which constitue a threat to the U.S. livestock industry. (Public Law 496; 62 Stat. 198)

June 16, 1948: An act authorizing the Weather Bureau to study the causes and characteristics of thunderstorms, hurricanes, cyclones and other atmospheric disturbances. (Public Law 657; 62 Stat. 470)

June 16, 1948: The National Heart Act authorized the National Heart Institute to conduct, assist, and foster research; provide training; and assist the States in the prevention, diagnosis, and treatment of heart diseases. In addition, the act changed the

name of National Institute of Health to National Institutes of Health. (Public Law 80–655; 62 Stat. L.464)

June 24, 1948: The National Dental Research Act authorized the National Institute of Dental Research to conduct, assist, and foster dental research; provide training; and cooperate with the States in the prevention and control of dental diseases. (Public Law 80–755; Stat. L. 598)

August 22, 1949: The act authorized the Smithsonian Institute to continue anthropological research among the American Indians. Also authorized appropriations for maintenance of the Astrophysical Observatory, and for other expenses of the Smithsonian Institution. (Public Law 259; 63 Stat. 623)

October 25, 1949: The act authorized construction and equipment of a radio laboratory building for the National Bureau of Standards. (Public Law 366; 63 Stat. 886) Another act approved this date authorized construction of a guided-missile research laboratory building for the National Bureau of Standards. (Public Law 386; 63 Stat. 905)

October 27, 1949: The Unitary Wind Tunnel Act authorized the construction of $136 million for new NACA facilities, $10 million for wind tunnels at universities, $6 million for a wind tunnel at the David W. Taylor Model Basin, and $100 million for the establishment of the Air Force Arnold Engineering Development Center at Tullahoma, Tenn., in recognition of the fact that industry could not subsidize expensive wind tunnels for research in transonic and supersonic flight. (Public Law 415; 63 Stat. 933)

May 10, 1950: National Science Foundation Act of 1950 established a Federal agency, the National Science Foundation, for the specific purpose of promoting the progress of science in the Nation. The Foundation was directed to carry out its mission by developing a national policy for the promotion of basic research and education in the sciences. The act was the culmination of a five-year post World War II effort to assure that the United States would continue to have a science reservoir of research and trained manpower. (Public Law 81–507; 64 Stat. 149)

July 21, 1950: The National Bureau of Standards was authorized to use funds for certain enumerated activities, including laboratory and office rental space, the purchase of reprints, and subsistence and research in the Arctic region. (Public Law 618; 64 Stat. 370)

July 22, 1950: The Act of March 3, 1901 which established the National Bureau of Standards was amended by this act which in enumerating the basic authority of the Department of Commerce for its scientific functions also redescribed the functions of the Bureau. (Public Law 619; 64 Stat. 371)

August 8, 1950: The act directed the National Advisory Committee for Aeronautics to equip and operate research stations, and authorized $16.5 million to expand existing facilities. (Public Law 672; 64 Stat. 418)

August 15, 1950: The Omnibus Medical Research Act authorized the Surgeon General to establish the National Institute of Neurological Diseases and Blindness, as well as additional institutes, to conduct and support research and research training relating to other diseases and group of diseases. (Public Law 81–692; 64 Stat. 443.) (The National Institute of Arthritis and Metabolic Diseases

and the National Institute of Neurological Diseases and Blindness were established under the authority of this act on November 22, 1950. Under this same act, the National Institute of Allergy and Infectious Diseases was established on December 29, 1955, replacing the National Microbiological Institute which was originally established November 1, 1948, under authority of section 202 of the Public Health Service Act.)

September 9, 1950: This act established a clearing house for the collection and dissemination of technological, scientific, and engineering information in the Department of Commerce as a service to business and industry. (Public Law 776; 64 Stat. 823)

April 20, 1951: An 11-member Science Advisory Committee in the Office of Defense Mobilization, within the Executive Office, was established by President Truman "to advise the President and Mobilization Director Charles E. Wilson in matters relating to scientific research and development for defense."

February 1, 1952: Invention Secrecy Act of 1951 provided for the withholding of certain patents that might be detrimental to the national security. (Public Law 256; 66 Stat. 3)

May 13, 1952: Construction of a new geomagnetic station to be operated by the Coast and Geodetic Survey was authorized.

Secretary of Commerce was authorized to engage in research in science of geomagnetism and to conduct development work to improve magnetic procedures and instruments (Public Law 338; 66 Stat. 70)

June 23, 1952: Additional aeronautical research facilities were authorized by this act for the National Advisory Committee for Aeronautics. (Public Law 403; Stat. 153)

July 3, 1952: This act authorized the Secretary of the Interior to conduct research and development on the problem of desalination. Funds for acquiring property and facilities and contract authority were authorized. The Secretary shall coordinate activities with the Secretary of Defense where feasible. (Public Law 448; 66 Stat. 328)

July 16, 1952: Military research and development was the subject of this act which authorized the Secretaries of the 3 military departments to establish advisory committees and appoint part-time personnel necessary for research and development activities, and to make 5-year contracts, with extension rights, to carry out this program. The act also required the Secretary of each department to report on contracts entered into every six months. The objective of the act was to facilitate the performance of research and development work in the armed forces. (Public Law 557; 66 Stat. 725)

January 1, 1953: By Act of July 19, 1952, earlier acts relating to patents were revised and codified, effective this date. (66 Stat. 702)

March 9, 1953: President Eisenhower appointed Admiral Lewis L. Strauss as a Special Assistant to serve him as "liasion adviser on atomic energy matters." He occupied this post and shortly thereafter that of Chairman of the AEC until 1958.

April 11, 1953: Reorganization Plan No. 1 of 1953 creating a Department of Health, Education, and Welfare went into effect this

date. By this action Cabinet representation was accorded to Government functions in health, education and welfare.

June 26, 1953: An Act redefining Federal assistance for cooperative agricultural extension work, and repealing a number of acts which amended the Smith-Lever Act of May 8, 1941. (Public Law 83; 67 Stat. 83)

July 10, 1953: A new Commission on Organization of the Executive Branch (Second Hoover Commission) was set up by this act to study and recommend regarding functions which are not necessary to Government efficiency or which compete with private enterprise. (Public Law 108; 67 Stat. 142)

August 8, 1953: By legislation approved this date, the limitation in the National Science Foundation Act of 1950 which restricted its appropriation to $15 million in any fiscal year was removed. (Public Law 88–233; 67 Stat. 488)

August 13, 1953: Created a national advisory committee to study public and private methods of weather control and modification. (Public Law 256; 67 Stat. 559)

March 17, 1954: President Eisenhower issued E.O. 10521, which clarified and defined Federal agencies' responsibilities for research and development, and specified a broader role for the NSF than that in its 1950 charter by providing that the Foundation "shall from time to time recommend to the President policies for the Federal Government which will strengthen the national scientific effort and furnish guidance toward defining the responsibilities of the Federal Government in the conduct and support of scientific research."

May 13, 1954: This act created the Saint Lawrence Seaway Development Corporation and authorized U.S. participation with Canada in development of a St. Lawrence Seaway. (Public Law 358; 68 Stat. 92)

May 27, 1954: Authorized construction of certain aeronautical research facilities by National Advisory Committee for Aeronautics to be used for research for ICBM fuel and high-speed seaplane figures. (Public Law 371; 68 Stat. 142)

July 28, 1954: Authorized research work of the Department of Agriculture to be conducted by private contracts. Amended Act of June 29, 1935 (the Bankhead-Jones Act). (Public Law 545; 68 Stat. 574)

August 26, 1954: The Supplemental Appropriations Act, 1955, appropriated $2 million to the National Science Foundation to support the U.S. International Geophysical Year program sponsored and coordinated by the National Academy of Sciences. This was the initial appropriation for the IGY program. (Public Law 663; 58 Stat. 818)

August 30, 1954: The Atomic Energy Act of 1954 to amend the Atomic Energy Act of 1946. Facilitated industrial uses of atomic energy: authorized exchange of information with friendly free governments and encouraged formulation of an international atomic pool for peaceful purposes. This was the first major amendment of the Atomic Energy Act of 1946. (Public Law 83–703; 68 Stat. 919)

May 23, 1955: Still another evidence of recognition of the need to promote aeronautical research for defense purposes was this au-

thorization to the National Advisory Committee for Aeronautics for the construction of certain research facilities. Total cost was not to exceed $13.3 million. (Public Law 44; 69 Stat. 65)

June 28, 1955: This act authorized the construction of a building for a Museum of History and Technology for the Smithsonian Institution. (Public Law 106; 69 Stat. 189)

June 29, 1955: Amended the Act of July 3, 1952 relating to research in the development and utilization of saline water by providing for cooperation with additional Federal agencies and foreign public or private agencies. Authorized total funding of $10 million for period fiscal 1953 to 1963. (Public Law 111; 69 Stat. 198)

June 30, 1955: Further International Geophysical Year funding. The Independent Offices Appropriations Act of 1956, appropriated $10 million to the National Science Foundation, to remain available until June 30, 1960, for the U.S. IGY program. (Public Law 112; 69 Stat. 208)

July 14, 1955: An act authorizing the Secretary of Health, Educaton, and Welfare and the Surgeon General of the Public Health Service, in cooperation with State and local governments and public and private agencies and institutions, to recommend research programs, to provide technical assistance and encourage cooperative action for eliminating or reducing air pollution.

July 28, 1955: The Mental Health Study Act authorized the Surgeon General to award grants to nongovernmental organizations for partial support of a nationwide study and reevaluation of the problems of mental illness. Under this act, the Joint Committee on Mental Illness and Health was awarded grant support for 3 years. (Public Law 84-182; 69 Stat. L. 381)

May 10, 1956: Executive Order 10668 amended Executive Order 2859 of May 11, 1918, which formally established the National Research Council. The new Executive order clarified Government representation on the Council.

May 19, 1956: National Science Foundation received an appropriation of $27 million to remain available until June 30, 1960, for the International Geophysical Year under the Second Supplemental Appropriations Act, 1956. (Public Law 533; 70 Stat. 167)

July 3, 1956: The National Health Survey Act authorized the Surgeon General to survey sickness and disabilities in the United States on a sampling basis. (Public Law 84-652; 70 Stat. L. 489)

July 28, 1956: The Alaska Mental Health Enabling Act provided for territorial treatment facilities to eliminate the need to transport the mentally ill outside Alaska. It also authorized Public Health Service grants to Alaska for its mental health program. (Public Law 84-830; 70 Stat. L. 709)

July 30, 1956: The Health Research Facilities Act of 1956 authorized a Public Health Service program of Federal matching grants to public and nonprofit institutions for the construction of health research facilities (Public Law 84-835; 70 Stat. L. 717)

August 2, 1956: The Health Amendments Act of 1956 authorized the Surgeon General to assist in increasing the number of adequately trained nurses and professional public health personnel. It also authorized Public Health Service grants to support the development of improved methods of care and treatment of the mentally ill. (Public Law 84-911; 70 Stat. L. 923)

August 3, 1956: This act established a National Library of Medicine in the Public Health Service. (Public Law 941; 70 Stat. 960)

August 28, 1957: Supplemental Appropriation Act, 1958, appropriated $34,200,000 for the U.S. scientific satellite "to be derived by transfer from such annual appropriations available to the Department of Defense as may be determined by the Secretary of Defense, to remain available until expended." (Public Law 85-170; 71 Stat. 428)

September 2, 1957: Up to $45,450,000 was authorized by this act for the construction of aeronautical research facilities and land acquisition by the National Advisory Committee for Aeronautics. (Public Law 85-253; 71 Stat. 568)

November 7, 1957: President Dwight D. Eisenhower announced the creation of the Office of Special Assistant to the President for Science and Technology, and appointed James R. Killian, Jr., to be his first science advisor. (Radio and television address to the Nation, this date.)

November 27, 1957: Science Advisory Committee of Office of Defense Mobilization was transferred to the Executive Office of the President, and enlarge and reconstituted, was redesignated the President's Science Advisory Committee. The action was taken to provide a more direct relationship between the Committee, the President, and the Special Assistant for Science and Technology.

July 11, 1958. An amendment to the National Science Foundation Act of 1950 authorized and directed the Foundation "to initiate and support a program of study, research, and evaluation in the field of weather modification." (Public Law 85-510; 72 Stat. 353)

July 21, 1958: House Committee on Science and Astronautics established by passage of House Resolution 580.

July 24, 1958: The Senate created a new standing Committee on Aeronautical and Space Sciences. (Senate Resolution 327)

July 29, 1958: National Aeronautics and Space Act of 1958 established the National Aeronautics and Space Administration and a National Aeronautics and Space Council and defined responsibility for space activities. In a statement issued at the signing of the law, President Eisenhower said: "The present National Advisory Committee for Aeronautics (NACA) with its large and competent staff and well-equipped laboratories will provide the nucleus for NASA. The NACA has an established record of research performance and of cooperation with the armed services. The coordination of space exploration responsibilities with NACA's traditional aeronautical research functions is a natural evolution * * * [one which] should have an even greater impact on our future." (Public Law 85-568; 72 Stat. 426)

July 29, 1958: The National Aeronautics and Space Act of 1958 which established the National Aeronautics and Space Administration also established a 9-member advisory National Aeronautics and Space Council, consisting of the President and other named representatives.

August 1, 1958: Authorized the Department of the Interior to undertake continuing studies of effects of insecticides, herbicides, fungicides and pesticides upon fish and wildlife. (Public Law 85-582; 72 Stat. 479)

August 23, 1958: Federal Aviation Agency created with passage by Congress of the Federal Aviation Act. (Public Law 726; 72 Stat. 731) (FAA was transferred to the Department of Transportation by the act of Oct. 15, 1966 which established the Department)

September 2, 1958: National Defense Education Act of 1958. This was the first general Federal aid-to-education legislation since the Morrill Act of 1862. Major administrative responsibility for the Act was assigned to the Department of Health, Education, and Welfare. Title IX of the Act created a Science Information Service in the National Science Foundation under the direction of a Science Information Council. This latter action was evidence of congressional recognition of the science information problem and an attempt to deal with it. (Public Law 85-864; 71 Stat. 1580)

September 2, 1958: A joint resolution directing the Secretary of the Interior to contract for the construction of demonstration plants for the production of usable water from saline water. (Public Law 85-883; 72 Stat. 1706)

March 13, 1959: By E.O. 10807, President Eisenhower established the Federal Council for Science and Technology, consisting of his Special Assistant for Science and Technology and representatives of the major science-oriented departments and agencies, to promote interagency cooperation and coordination in the planning and management of Federal scientific and technological programs.

E.O. 10807 amended E.O. 10521 of March 17, 1954, to limit the National Science Foundation's policy advisory role to basic scientific research and education in sciences, rather than "scientific research" in general as the 1954 E.O. had specified. A new section 10 of E.O. 10807 gave the Foundation a leadership role in the coordination of Federal scientific information activities of the Federal Government.

E.O. 10807 also abolished the Interdepartmental Committee on Scientific Research and Development.

September 8, 1959: An amendment to the National Science Foundation Act of 1950 clarified the Foundation's authority to support programs to strengthen the nation's scientific research potential. (Public Law 86-232; 73 Stat. 467)

September 23, 1959: This act defined procedures and criteria whereby the Atomic Energy Commission may "turn over" to individual States certain defined areas of regulatory jurisdiction over atomic materials.

The act also established a Federal Radiation Council to advise the President on radiation matters. (Public Law 86-373)

April 1960: The Subcommittee on National Policy Machinery of the Senate Committee on Government Operations held a series of hearings, entitled "Science, Technology, and the Policy Process."

July 7, 1960: This law sought to encourage and stimulate the production and conservation of coal in the United States by authorizing the Secretary of the Interior to establish an Office of Coal Research and contract for research to develop better methods of mining, preparing and utilizing coal. (Public Law 86-599)

September 9, 1960: Authorized the Surgeon General to make project grants to schools of public health and schools of nursing or engineering which provide graduate or specialized training in

public health for nurses or engineers, in order to strengthen and expand training in these areas. (Public Law 86–720)

April 25, 1961: An amendment to the National Aeronautics and Space Act of 1958 revised the membership and functions of the National Aeronautics and Space Council and brought the Council into the Executive Office of the President, with the Vice President as Chairman. (Public Law 87–26; 75 Stat. 46)

June 14, 1961: The Subcommittee on National Policy Machinery submitted a study entitled "Science Organization and the President's Office" to the Senate Committee on Government Operations, recommending the creation of an Office of Science and Technology within the Executive Office of the President.

September 22, 1961: the saline water conversion program was expanded and extended by this act which amended the act of July 3, 1952. Authority of the Secretary of the Interior to conduct research and development activities and to cooperate with other Federal agencies was extended in considerable detail. (Public Law 87–295; 75 Stat. 628)

September 26, 1961: A United States Arms Control and Disarmament Agency was established by this act. Section 31 of Title III set forth for range of research activities which the Director was authorized to engage in. The creation of a separate agency was evidence of the United States intention to move ahead toward agreements for reduction and control of armaments, including thermonuclear, nuclear, missile, conventional, bacteriological, chemical, and radiological weapons. (Public Law 87–297; 75 Stat. 631)

June 8, 1982: In the absence of Congressional disapproval, Reorganization Plan No. 2 of 1962, establishing the Office of Science and Technology in the Executive Office of the President, became effective. The Plan transferred certain functions from the National Science Foundation to the new OST relating to the coordination of Federal policies for the promotion of basic research and education in the sciences, and those functions with respect to the evaluation of scientific research programs of Federal agencies. (27 F.R. 5419)

August 31, 1962: Communications Satellite Act of 1962 created a private communication satellite system to serve the needs of the United States and other countries. (Public Law 87–624; 76 Stat. 419)

October 17, 1962: This act authorized the Surgeon General to establish the National Institute of General Medical Sciences and the National Institute of Child Health and Human Development. The latter was authorized to conduct and support research and training related to maternal heatlh; child health; human development, in pariticular the special health problems of mothers and children; and the basic sciences relating to the processes of human growth and development. The former was authorized to conduct and support research in the basic medical sciences and related behavioral sciences which have significance for two or more institutes, or which are outside the general area of responsibility of any other institute. (Public Law 87–838; 76 Stat. L. 1072) (On January 30, 1963, the National Insititute of Child

Health and Human Development and the National Instiute of General Medical Sciences were established under this act.)

October 16—November 20, 1963: The Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics held its initial hearings, entitled "Government and Science," to identify problems in the Government-science relationship and to assign priorities for dealing with them.

December 5, 1964: National Academy of Engineering of the NAS-NRC was established with the adoption by the Council of the NAS of Articles or Organization making the new Academy a parallel organization.

July 13, 1965: Environmental Science Service Administration established with entry into force of Reorganization Plan 2 of 1965, effective this date. Transferred to the new agency were in the Weather Bureau, the Coast and Geodetic Survey, and the Central Radio Laboratory of the NBS.

July 22, 1965: Water Resources Planning Act provided for comprehensive planning for water resources development to be carried out by Federal-State River Basin Commissions reporting the President through a Cabinet level Water Resources Council. (Public Law 89-80; 79 Stat. 244)

September 14, 1965: State Technical Services Act of 1965 was an attempt to make more readily available to American business, commerce and industry the benefits of federally financed research and other research by providing a national program of incentive and support to the States who establish and maintain technical service programs to accomplish the above objective. (Public Law 89-182; 79 Stat. 679)

September 30, 1965: This act authorized the Secretary of Commerce to undertake research and development in high-speed ground transportation, to undertake demonstration projects to assess public response to improvements in intercity rail passenger service, and to embark on a national program to improve the scope and availability of transportation statistics. The act provided for Federal assistance in an area which private rail carriers could no longer handle due to loss of business because of competition from other forms of transportation. (Public Law 89-220; 79 Stat. 893)

October 2, 1965: Water Quality Act of 1965 strengthened Federal water programs by creating a new agency, the Federal Water Pollution Control Administration to administer the program under the Secretary of Health, Education, and Welfare. A new research and demonstration program was authorized relating to controlling sewage from storm sewers. Funding for ongoing research was increased as were program and construction grants. (Public Law 89-234; 79 Stat. 903)

June 17, 1966: Public Law 89-454 established a temporary National Council on Marine Resources and Engineering Development in the Executive Office of the President under the chairmanship of the Vice President to plan and develop a coordinated Federal program in marine science activities. The legislation also established a Commission on Marine Science. Engineering and Resources to make a comprehensive investigation and study of marine science and recommend an overall plan for a national oceanographic program.

The National Council on Marine Resources went out of existence June 30, 1971, following the submission of the Commission's final report.

October 15, 1966: A Department of Transportation was established by this act which brought together several Federal agencies with missions relating to automobile, rail and air travel. In fullfillment of a Congressional finding that technological advances in transportation required stimulation, the Secretary of Transportation was authorized to undertake research and development in all modes of transportation and facilities. (Public Law 89–670; 80 Stat. 931)

November 8, 1967: Membership of the Federal Council for Science and Technology was enlarged by the addition of representatives from the Department of State, the Department of Housing and Urban Development, and the Department of Transportation. (Executive Order 11381, this date.)

January 2, 1968: An act extending the time for the National Commission on Marine Science, Engineering, and Resources to render its report to January 9, 1969, and authorizing the continuation of the National Council on Marine Resources and Engineering development until June 30, 1969. (Public Law 90–242; 81 Stat. 780)

July 11, 1968: This act authorized the Secretary of Commerce to arrange for the collection of standard reference data for the benefit of scientists and the general public. The Act is administered by the National Bureau of Standards. (Public Law 90–396; 82 Stat. 339)

July 18, 1968: Amendments to the National Science Foundation Act of 1950 constitute the first major amendment of the enabling act, although several minor changes have preceded it. The act clarifies the administrative direction of the agency as between the Director and the National Science Board. In addition, it enables the Foundation to support applied research relevant to its mission and it emphasizes the Foundation's responsibilities to report on the status of science in the Federal Government. The act also requires the Foundation to obtain annual authorization for its funds, replacing the continuing authorization conained in the original legislation. (Public Law 90–407; 82 Stat. 360)

July 21, 1968: Aircraft Noise Abatement Act of this date amended the Federal Aviation Act to impose regulations for the abatement of aircraft noise. The Federal Aviation Administration is empowered to set aircraft noise and sonic boom standards for commercial aircraft. Aircraft will be certified for flying only if they conform to these standards. (Public Law 90–411; 82 Stat. 395)

August 9, 1968: The question whether the metric system should be adopted in the United States becomes of greater concern as more and more nations adopt it. Congress took an important step with this bill which authorized the Secretary of Commerce to study the advantages and disadvantages of increased use of the metric system in the United States and to report on the matter to Congress within 3 years (Public Law 90–472; 82 Stat. 693). A final report and 12 supporting studies were transmitted to Congress in 1971.

August 16, 1968: A National Eye Institute in the National Institutes of Health was approved with the passage of the National Eye Institute Act. The Institute will focus on curing and preventing blindness, and other eye disorders and will conduct and support research and training on the health problems and needs of the blind. It is hoped that the creation of a separate institute devoted to the problems of sight will result in significant advances in this field. (Public Law 90-489; 82 Stat. 771)

September 26, 1968: This act established a National Water Commission to review water resources problems and programs. The presidentially appointed commission is expected to submit recommendations that will aid in more efficient use of existing water supplies and suggest new ways to develop water. (Public Law 90-515; 82 Stat. 868). The final report of the Commission was submitted June 14, 1973 and the Commission went out of existence later that year.

October 18, 1968: Radiation Control for Health and Safety Act of 1968 amended the Public Health Service Act to insert safeguards to workers and consumers who make or use electronic products, to assure against "unnecessary hazardous radiation." Safety standards are to be set by the Secretary of Health, Education, and Welfare after consultation with the Commerce Department (National Bureau of Standards) and advisory committees represented by government, industry and the general public. The legislation is significant because electronic products are manufactured and used so widely that almost the entire population of the nation can be affected by potential radiation damage. (Public Law 90-602; 82 Stat. 1173)

March 5, 1970: By E.O. 11514, responsibilities of the Council on Environmental Quality in the Executive Office of the President, which had been established by P.L. 91-190, were set forth.

July 1, 1970: By Reorganization Plan No. 2 of 1970 and E.O. 11541, July 1, 1970, the Bureau of the Budget in the Executive Office of the President was redesignated as the Office of Management and Budget.

Reorganization Plan No. 2 also established a Domestic Council in the Executive Office of the President. Duties of the Council, including the developing for the President of alternative proposals for reaching national domestic goals, and providing policy advice to the President on domestic issues, were spelled out in E.O. 11541.

July 1, 1971: Domestic Council New Technology effort started under William M. Magruder.

August 16, 1971: Public Law 92-125 established the National Advisory Committee on Oceans and Atmosphere. The basic Act directed NACOA to (1) perform a continuing review of the progress of the marine and atmospheric science and service programs of the United States; (2) advise the Secretary of Commerce with respect to the carrying out of the purposes of the National Oceans and Atmospheric Administration; and (3) report annually to the President and to the Congress its findings and recommendations, setting forth an overall assessment of the status of the Nation's marine and atmospheric affairs and activities.

October 26, 1971: P.L. 91–510, Legislative Reorganization Act of 1970, approved this date, directed the first major Congressional reorganization since the Legislative Reorganization Act of 1946. Among the provisions of the Act were the assignment of review and analytical responsibilities to the General Accounting Office and the complementary strengthening of the Legislative Reference Service, redesignated Congressional Research Service to emphasize its research responsibilities.

January 1973: The pro forma resignations of the President's Science Advisory Committee preceding the start of a new Presidential administration were accepted and new members were not appointed.

January 3, 1973: The White House announced that Dr. Edward E. David, Jr. had resigned his positions as Presidential Science Adviser and Director, Office of Science and Technology, to return to private industry.

January 26, 1973: Reorganization Plan No. 1 of 1973 transmitted to the Congress. The plan provided for the abolishment and/or transfer out of the Executive Office of the President to the Office for Emergency Planning, the Office of Science and Technology, and the National Aeronautics and Space Council. Certain functions of the Office of Science and Technology were transferred to the Director of the National Science Foundation.

April 4, 1973: In H. Rept. 93–106, the House Committee on Government Operations noted that since a disapproving resolution had not been introduced, it was not required to report for or against Reorganization Plan No. 1 of 1973. However, the Committee came to the conclusion that the Plan should not be opposed, despite the problems and uncertainties regarding its operation.

April 5, 1973: Sixty-day period for Congressional disapproval on Reorganization Plan No. 1 of 1973 ended this date. Plan to go into effect July 1, 1973, as specified therein.

June 29, 1973: President Nixon announced the appointment of John A. Love to be an Assistant to the President for Energy and the Director of a new Energy Policy Office to be established in the Executive Office of the President. He also announced the creation of an Energy Research and Development Council, to consist of experts in the field from outside Government, to advise the Energy Policy Office.

The President further proposed the establishment of a new Cabinet-level Department of Energy and Natural Resources and an Energy Research and Development Administration.

July 1, 1973: Reorganization Plan No. 1 of 1973 went into effect.

July 1, 1973: International scientific and technical activities formerly performed by the Office of Science and Technology were transferred to the Director of the National Science Foundation.

July 2, 1973: NSF Director Stever established a Science and Technology Policy Office and named Dr. Russell C. Drew, Director. The Office also provided staff support for the Federal Council for Science and Technology, chaired by Dr. Stever.

July 10, 1973: President Nixon announced the designation of Dr. H. Guyford Stever, Director of the National Science Foundation, as Chairman of the Federal Council for Science and Technology and as Science Adviser to the President. The assignment of these re-

sponsibilities was made in a letter of July 1, 1973, from the President to Dr. Stever.

July 17–24, 1973: House Committee on Science and Astronautics held four days of hearings on Federal policy, plans and organization for science and technology, with particular reference to how Reorganization Plan No. 1 of 1973 was being implemented by the Director of the National Science Foundation.

September 27, 1973: S. 2495, Technology Resources Survey and Applications Act, introduced by Senators Magnuson, Moss and Tunney. Referred to Committee on Aeronautical and Space Science and Committee on Commerce. Concepts in this bill were incorporated into S. 32 which passed the Senate October 9, 1974.

November 7, 1973: In an address to the Nation on the energy emergency, President Nixon requested Congress to act on the proposal for an Energy Research and Development Administration apart from the pending new Department of Energy and National Resources proposal.

December 1, 1973: AEC Chairman Dixy Lee Ray presented her findings and recommendations to the President to implement a five-year $10 billion national energy research and development program. One of the recommendations was to establish an operational Energy Research and Development Administration not later than July 1, 1974.

December 4, 1973: OMB Associate Director for Natural Resources, Science, and Energy John C. Sawhill was appointed Deputy Director of the newly-created Federal Energy Office in the Executive Office of the President.

February 1, 1974: The Council of the National Academy of Sciences announced the establishment of an ad hoc committee under the chairmanship of James R. Killian Jr. to look broadly at the relationships between science and technology with a view to assuring the best use of scientific and technical judgments in the development of public policy and in planning and management of Federal research and development. A report was expected within four to six months.

May 7, 1974: Federal Energy Administration was established by P.L. 93–275 as an independent executive agency, replacing the Federal Energy Office in the Executive Office of the President.

May 31, 1974: The President signed S. 775 into law (Public Law 93–296, Title IV) to establish a National Institute on Aging within the National Institutes of Health. NIA was directed to support and conduct biomedical, social, and behavioral research and training in the field of aging. The Institute has the responsibility of developing a national comprehensive research plan designed to coordinate and promote research in the field of aging. It also supports projects investigating a wide range of factors affected by the aging process from psychological changes to the effects of social, economic and physical dependency.

June 20–July 18, 1974: The House Committee on Science and Astronautics held nine days of hearings in the second phase of the committee's inquiry into Federal policy, plans, and organization for science and technology. Twenty-six witnesses gave testimony; several other individuals submitted statements for the record.

June 26, 1974: Appearing as a witness before the House Committee on Science and Astronautics. James R. Killian, Jr. presented the findings of the ad hoc Committee on Science and Technology of the National Academy of Sciences on the general question of scientific and technical advice to the government, including the advisory and coordinating functions previously carried out by the White House science advisory complex. The report, entitled "Science and Technology in Presidential Policymaking: A Proposal" recommended the establishment of a Council for Science and Technology as a staff office in the Executive Office of the President.

June 26, 1974: The Chairman of the House Committee on Science and Astronautics directed his staff to begin drafting legislation to improve the advisory, planning and organizational aspects of Federal science policy.

June 27, 1974: Senators Magnuson, Moss and Tunney introduced an amendment (No. 1537) to S. 2495 which would provide for the establishment of a Council of Advisors on Science and Technology in the Executive Office of the President and the submission of an annual science and technology report.

July 11, 1974: Senate Committee on Commerce and Committee on Aeronautical and Space Sciences held a joint hearing on amendment No. 1537 to S. 2495.

September 18, 1974: Senate Commerce Committee and the Committee on Aeronautical and Space Sciences reported favorably S. 2495, amended, to establish a Council of Advisors on Science and Technology in the Executive Office of the President, and an interagency Federal Coordinating Council on Science and Technology to replace the Federal Council for Science and Technology, and to direct the President to transmit an annual science and technology report to Congress. Referred to Committee on Labor and Public Welfare.

October 7, 1974: The National Institutes of Health established the Recombinant DNA Molecule Program Advisory Committee. The Committee later changed its name to the Recombinant DNA Advisory Committee (RAC). RAC assists the Director of NIH in all matters involving the regulation of recombinant DNA.

October 7, 1974: The National Institute on Aging was established. Dr. Robert Butler was appointed Director.

October 11, 1974: President Ford signed the Energy Reorganization Act of 1974 (Public Law 93-438).

October 11, 1974: By Executive Order 11814, the Energy Resources Council authorized by Public Law 93-438 was activated, and the Secretary of the Interior was named Chairman. The Council, located in the Executive Office of the President, was charged with developing a single national energy policy and program, and performing such other functions as was assigned to it by the President.

December 21, 1974: President Ford asked Vice President Rockefeller to study the question of whether the system of a White House science advisor should be revived, and if so, in what form, and to report to him his recommendations "in a month or so from now."

December 31, 1974: Federal Nonnuclear Energy Research and Development Act of 1974 (Public Law 93-577) set forth the duties

and authorities of the Administrator of the Energy Research and Development Administration, outlined a program Federal assistance and demonstrations, defined the patent policy for inventions developed under ERDA contracts, and provided for assistance in developing energy related inventions.

January 19, 1975: By Executive Order 11834, of January 15, 1975, President Ford directed the activation of the Energy Research and Development Administration and the Nuclear Regulatory Commission.

April 30, 1975: S. 1608 was introduced in the Senate. The bill would have amended the Drug Abuse and Treatment Act of 1972 to establish an Office of Drug Abuse Policy in the Executive Office of the President. The new office would replace the Special Action Office for Drug Abuse Prevention which had been established by the 1972 Act.

December 23, 1975: Metric Conversion Act of 1975 was signed into law (Public Law 94–168). The Act declared that the policy of the U.S. shall be to coordinate and plan the increasing use of the metric system in the United States and to establish a U.S. Metric Board to coordinate the voluntary conversion to the Metric System.

March 19, 1976: S. 2017, amendment to the Drug Abuse and Treatment Act of 1972 was signed into law (Public Law 94–237) by the President. The Director of the new Office of Drug Abuse Policy was instructed to make recommendations to the President with respect to policies for, objectives of, and establishment of priorities for, Federal drug abuse functions and to coordinate the performance of such functions by Federal departments and agencies. Employment of experts and consultants was authorized.

May 11, 1976: President Ford signed H.R. 10230 (Public Law 94–282) the National Science and Technology Policy, Organization, and Priorities Act of 1976. The new law set forth a national policy for science and technology; established an Office of Science and Technology Policy (OSTP) within the Executive Office of the President; directed the establishment of a temporary President's Committee on Science and Technology to survey the overall Federal science, engineering, and technology effort; replaced the Federal Council for Science and Technology set up in 1959 with a Federal Coordinating Council for Science. Engineering, and Technology to be under the chairmanship of the Director of OSTP; and provided for the establishmet of an Intergovernmental Science, Engineering and Technology Advisory Panel to advise the OSTP Director on the optimum utilization of Federal research efforts to improve the scientific and technological capabilities of the State Governments.

June 15, 1976: "Guidelines For Research Involving Recombinant DNA" was issued by the National Institutes of Health. The guidelines, which were developed by the Recombinant DNA Advisory Committee, imposed restrictions on the types of federally supported experiments that can be performed and specified levels of physical and biological containment for recombinant DNA experiments. Industry has voluntarily complied with the new Federal regulations.

August 6, 1976: The Energy Conservation and Production Act was signed into law (Public Law 94–385). It provided for an extension until December 31, 1977, of the Federal Energy Administration and of the Energy Resources Council. The Act also directed the Council to prepare a report on comprehensive energy reorganizations.

August 12, 1976: Dr. H. Guyford Stever was sworn in as the first Director, Office of Science and Technology Policy.

December 2, 1976: The organization of the new Federal Coordinating Council for Science, Engineering, and Technology under Public Law 94–282 was announced. The interagency committees of the predecessor Federal Council for Science and Technology were consolidated into six new problem area committees and four R&D policy and management areas.

January 1977: The Energy Resources Council filed its report, as directed in Public Law 94–385, on energy reorganization. The report titled "The Organization of Federal Energy Functions" recommended the establishment of a Department of Energy.

January 20, 1977: Dr. H. Guyford Stever, Director, Office of Science and Technology Policy submitted his resignation to President Carter.

February 4, 1977: The Senate adopted S. Res. 4, as amended. The resulting committee reorganization affected most of the science and technology related committee jurisdictions. Major changes included: Creation of the Agriculture, Nutrition, and Forestry Committee incorporating all the jurisdictions of the Select Committee on Nutrition and Human Needs, which was abolished as of December 31, 1977; creation of the Commerce, Science, and Transportation Committee, which incorporated all the areas of the abolished Aeronautical and Space Science Committee; also among the new jurisdictional subjects to be handled by this committee were science, engineering, and technology research and development and policy: creation of the Energy and Natural Resources Committee incorporating most of the duties of the Interior and Insular Affairs Committee and creating a new set of jurisdictional subjects in the area of energy policy, regulation, and conservation: creation of the Environment and Public Works Committee creating new jurisdictional subjects in environmental policy, environmental research and development, solid waste disposal and recycling, and environmental effects of toxic substances.

February 7, 1977: Dr. Peter Bourne was appointed by President Carter to head the Office of Drug Abuse Policy.

June 1, 1977: Dr. Frank Press was sworn in as Director, Office of Science and Technology Policy.

June 21, 1977: Dr. Robert Frosch became the Administrator of the National Aeronautics and Space Administration. He had been Associate Director for Applied Oceanography at Woods Hole Oceanographic Institution.

July 5, 1977: Legislation authorizing fiscal year 1978 appropriations for the National Advisory Committee on Oceans and Atmosphere (Public Law 95–63) also changed the committee's membership from 25 to 18 members and established specific qualifications for individuals appointed to serve on NACOA.

July 15, 1977: Reorganization Plan No. 1 of 1977 was sent to the Congress by President Carter. All the science advisory, coordinating and study units in the Executive Office of the President were affected by the plan.

August 4, 1977: S. 826 was signed by President Carter and enacted into law (Public Law 95-91) creating the Department of Energy. The major provisions of the law called for the transfer to the new Department all functions of the Federal Energy Administration, the Federal Power Commission, and the Energy Research and Development Administration; selected and generally similar functions from the Interior Department; and elements from the Department of Housing and Urban Development, the Interstate Commerce Commission, the Naval Petroleum Reserves of the Department of Defense, and the Department of Commerce.

September 20, 1977: Public Law 95-110 abolished the Joint Committee on Atomic Energy. The committee's functions and responsibilities were reassigned to several House and Senate standing committees.

October 7, 1977: Enactment of Public Law 95-124, the "Earthquake Hazards Reduction Act of 1977," required the President to establish a national earthquake hazards reduction program and outlined a number of objectives including: The development of earthquake resistant construction; the implementation, in all areas of high or moderate seismic risk, of a system for predicting earthquakes; the development of model codes to coordinate information about seismic risk with land-use policy decisions and building activity; and the development of basic and applied research programs leading to better understanding of the control or alternation of seismic phenomena. The President was to designate, within 30 days of enactment, the Federal department responsible for development of the outlined program.

October 19, 1977: The period for congressional action on Reorganization Plan No. 1 of 1977 ended at midnight this date. The House had rejected a resolution of disapproval on October 14; the Senate did not vote on the resolution.

February 24, 1978: President Carter signed Executive Order 12039 setting an effective date of February 26, 1978, for the following actions: the responsibilities for the preparation of the annual science and technology report and the five-year forecast of current and emerging problems were transferred from the Director of OSTP to the Director of NSF. The Intergovernmental Science, Engineering, and Technology Advisory Panel (ISETAP) and the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET), which were created under Public Law 94-282 (May 11, 1976) were dissolved and then reestablished as Executive Office advisory bodies abolishing their statutory basis. The President's Committee on Science and Technology (PCST) was abolish and its functions were transferred to the President. The Executive Order did not mention the section of Public Law 94-282 which directed the President to transmit the interim and final reports (surveying the overall Federal science, engineering, and technology effort) to the Congress within 60 days of receipt to be accompanied by appropriate comments, observations, and recommendations.

March 26, 1978: By Executive order 12046 President Carter abolished the Office of Telecommunications Policy (OTP) in the Executive Office of the President and transferred its functions among several government agencies, including the Department of Commerce; the Office of Management and Budget, the National Security Council, and the Office of Science and Technology Policy, all in the Executive Office of the President; and the Department of State. The Executive Order also established the Secretary of Commerce as the "President's principal advisor on telecommunications policies pertaining to the Nation's economic and technological advancement and to the regulation of the telecommunications industry." The National Telecommunications and Information Administration was established in the Department of Commerce to carry out the functions assigned to the Department.

June 19, 1978: The President sent Reorganization Plan No. 3 to the Congress, which included a proposal for the establishment of a Federal Emergency Agency. A number of hazard mitigation functions, including earthquake hazards reduction were to be consolidated in the new Agency which became the Federal Emergency Management Agency on April 1, 1979.

June 22, 1978: The President transmitted to Congress a plan for a National Earthquake Hazards Reduction Program. The President earlier had assigned responsibility for planning the Earthquake Hazards Reduction Program to the Office of Science and Technology Policy in the Executive Office of the President. The plan outlined Federal initiatives for earthquake hazards reduction including: development of seismic-resistant design and construction standards for application in Federal construction; assessment of hazards posed by existing Federal facilities; and studies of the financial aspects of earthquake hazards mitigation.

September 8, 1978: The First Annual Report on Science and Technology, as required by Public Law 94–282, was sent to the President by the National Science Foundation. The report examined the economic foundations for the Government's role in science and technology, including the contribution of R&D and innovation to productivity.

September 17, 1978: The National Climate Program Act was signed into law (Public Law 95–367). The Act directed the President of the United States to establish a national climate program and define the roles in this program for the twelve Federal agencies vested with responsibilities in climate research and services. Designed to centralize planning and to improve interagency and intergovernmental coordination, the Act emphasized early production and delivery of climate data, information and services to users, and expanded the research effort aimed at understanding the dynamics of climatic variability and its societal consequences.

October 7, 1978: The President signed Public Law 95–426, the Foreign Relations Authorization Act, Fiscal Year 1979. Title V of the act addressed science, technology, and American diplomacy and set forth a policy for the United States to maximize the benefits and to minimize the adverse consequences of science and technology in the conduct of foreign policy. The Secretary of State was given a primary responsibility for taking the steps nec-

essary to implement the policy. The legislation also required an annual report from the President to the Congress containing recommendations on: personnel requirements and standards for Federal personnel involved in foreign relations and science and technology, the continuation of existing bilateral and multilateral activities and agreements involving science and technology, including an analysis of the foreign policy implications and scientific benefits of such activities; the adequacy of funding and administration of such activities; and plans for future evaluation of such activities on a routine basis.

October 7, 1978: The National Commission on Research was founded as a private nonprofit organization to examine the relationship between government agencies and universities involved in research and to develop specific recommendations for improvements. The Commission investigated and prepared reports on the following research issues: accountability, peer review and other selection processes, alternative funding mechanisms, industry, university, and Government relationships, and development of research personnel.

November 6, 1978: The Surface Transportation Assistance Act of 1978, Public Law 95-599, established a National Alcohol Fuels Commission to study alcohol fuels. The study was completed in February 1981.

November 9, 1978: Public Law 95-622, the Community Mental Health Centers Extension Act of 1978 was signed into law. Title III established the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research.

November 9, 1978: The National Center for Health Care Technology was established in the Office for the Assistant Secretary for Health by a provision of the Health Services Research, Health Statistics, and Health Care Technology Act of 1978. (Public Law 95-623).

January 1, 1979: The United States and the People's Republic of China signed an agreement to begin scientific and technological exchanges between the two countries. A Joint Science and Technology commission co-chaired by the Office of Science and Technology Policy and the Chinese State Science and Technology Commission, coordinates and supervises activities under this agreement. This agreement is now the largest such bilateral program maintained by either country.

March 7, 1979: The House Committee on Science and Technology, Subcommittee on Science, Technology and Space began hearings to examine the status of U.S. research and development efforts by industry, universities, and national laboratories. The Subcommittee also assessed the role of the Office of Science and Technology Policy in managing Federal science and technology activities.

March 31, 1979: By Executive Order 12127, President Carter provided for the "orderly activation of the Federal Emergency Management Agency," (FEMA). The Executive Order, which took effect on April 1, 1979, transferred the United States Fire Administration, the Emergency Broadcast System, the National Flood Insurance Program, and the Earthquake Hazards Reduction Program into FEMA.

March 31, 1979: President Jimmy Carter appointed Gordon Vickery as the Acting Director of the newly created Federal Emergency Management Agency.

April 3, 1979: The House Committee on Science and Technology began three days of hearings to review the research and development portion of the Federal budget. The hearings examined how the research and development portion of the Federal budget is fashioned, managed, monitored and evaluated.

April 26, 1979: The Senate Committee on Labor and Human Resources, Subcommittee on Health and Scientific Research, began two days of hearings on the Health Sciences Promotion Act (S. 988). This bill would have created a President's Council on Health Sciences Research to advise the Congress and the Executive regarding priorities in research and revise and clarify present National Institutes of Health statutory authorities.

May 16, 1979: The House Committee on Science and Technology, Subcommittee on Science, Research, and Technology began four days of oversight hearings to review the National Science Foundation Act of 1950. The hearings initiated the first extensive review in over a decade by the subcommittee on the charter of the foundation. Specifically, the hearings were designed to evaluate NSF's role and priorities regarding support for basic research, applied science, and science education.

July 31, 1979: The House Committee on Science and Technology, Subcommittee on Science, Research, and Technology began hearings on Government and innovation: university-industry relations. The hearings focused on the potential of university and industry R&D cooperation to promote technological innovation and enhance industrial productivity. The hearings also examined H.R. 4672, the National Science and Technology Innovation Act of 1979. The Act propoised to amend the National Science Foundation Act of 1950, to establish a Commerce Department Office of Industrial Technology.

September 29, 1979: Public Law 96–72, the Export Administration Act, was signed into law. The legislation updated existing export control policy to ensure that export controls achieve their intended purposes, are not excessive, and focus on items (technology primarily) most important to national security.

October 17, 1979: Public Law 96–88, the Department of Education Organization Act established an executive department known as the Department of Education.

November 30, 1979: Shirley Mount Hufstedler was confirmed as the first secretary of the Department of Education. Prior to her confirmation, the secretary was a judge with the U.S. Court of Appeals, Ninth Judicial Circuit.

December 28, 1979: In reaction to the Soviet invasion of Afghanistan, President Jimmy Carter announced that only low-level scientific exchanges are to take place between the Soviet Union and the United States.

January 2, 1980: Enactment of Public Law 96–180, The Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment, and Rehabilitation Act Amendments of 1979. Among other things the Act required the Secretary of Health and Human Services to

support research on the social causes of alcohol abuse and alcoholism.

March 25, 1980: H.R. 6910 was introduced. It proposed the establishment of the National Technology Foundation to foster communication between scientific and technological agencies of the Federal Government and the small business community; operate programs of grants for the development of high technology; and collect, analyze, and publish information concerning grants and contracts awarded to small businesses. The act called for reorganization of several Federal agencies which would comprise the actual Foundation.

May 12, 1980: The National Science Foundation released its first *Five Year Outlook* on science and technology, to the President, as required by the National Science and Technology Policy, Organization and Priorities Act of 1976.

May 14, 1980: The Department of Health, Education, and Welfare became the Department of Health and Human Services (DHHS) as a result of the Department of Education Organization Act, Public Law 96-88, October 17, 1979.

July 17, 1980: The Ocean Thermal Energy Conversion (OTEC) Research, Development, and Demonstration Act was signed into law (Public Law 96-310). The Act set ambitious goals for OTEC development, including operation of an OTEC demonstration plant by 1986, an average cost of OTEC-generated electricity or energy product equivalent that is competitive in the mid-1990s with the cost of conventional energy sources in the U.S. Gulf Coast region and U.S. insular areas, and an installed (OTEC) capacity or energy product equivalent of 10,000 megawatts by the year 2000.

September 9, 1980: The House Committee on Science and Technology, Subcommittee on Science, Research and Technology, began five days of hearings on H.R. 6910, the proposed National Technology Foundation.

September 23, 1980: John B. Slaughter was confirmed as the new Director of the National Science Foundation.

October 7, 1980: The Magnetic Fusion Engineering Act of 1980 (Public Law 96-386) was signed into law. The Act set ambitious goals for fusion development, including operating of a fusion engineering device by 1990 and a magnetic fusion demonstration plant by the end of the 20th century.

October 15, 1980: Public Law 96-461, provided authorizations for fiscal years 1981 and 1982 for the Department of Commerce, including the National Bureau of Standards (NBS). This Act represents the beginning of annual authorization bills for the NBS, for the first time since its establishment.

October 21, 1980: Enactment of Public Law 96-479, the National Materials and Minerals Policy, Research and Development Act of 1980. The Act required the President to submit to Congress a plan to provide a suitable mechanism for the following: materials policy analysis and decision-making capability within the Executive Office of the President; continuing long-range analysis of materials used to meet national security needs, as well as to provide for economic, industrial and social needs; assessment of the adequacy and stability of materials supplies, and the industrial

and economic implications of supply shortages and disruptions; continuing private sector consultation in Federal materials programs; and interagency coordination at the level of the President's Cabinet.

October 21, 1980: Public Law 96–480, the Stevenson-Wydler Technology Innovation Act of 1980 was enacted to promote technological innovation for the achievement of national economic, environmental, and social goals. The legislation established an Office of Industrial Technology in the Department of Commerce. Among other things, the office was to provide financial assistance to universities or other nonprofit institutions to set up centers for industrial technology. The Act also mandates technology transfer from Federal labs to State and local governments and the private sector, creating several mechanisms to accomplish this. The Act also set up a National Industrial Technology Board to review the activities of the office and provide advice to the Secretary of Commerce.

December 12, 1980: Public Law 96–517, the Patent and Trademark Amendments of 1980, established a comprehensive and uniform policy for the ownership and licensing of inventions resulting from federally funded research and development as it relates to the ownership of such inventions by small businesses and nonprofit institutions, including universities and colleges, with only limited exemption, in order to promote the use of such inventions.

February 19, 1981: The director of the National Science Foundation established a separate engineering directorate within the foundation. The engineering and applied science directorate was abolished, with the applied sciences programs being distributed throughout the various NSF program areas.

May 6, 1981: Richard D. DeLauer, was confirmed as Under Secretary for Research and Engineering within the Department of Defense. Mr. DeLauer was instrumental in the establishment of the DOD-University Forum. One of the forums primary goals is to foster closer relations between the defense community and the Nation's university research and educational environment.

May 15, 1981: S. 1194 and S. 1200 were introduced by the Senate Committee on Commerce, Science and Transportation, and the Senate Committee on Labor and Human Resources respectively to authorize appropriations for the National Science Foundation (NSF). This marked the beginning of a dispute within the Senate over which committee has jurisdiction to report authorization bills for NSF. This dispute prevented the passage of an authorization bill, in the Senate for NSF, in both the 97th and 98th Congress.

June 23, 1981: The House Committee on Agriculture, Subcommittee on Department Operations, Research and Foreign Agriculture held a hearing on the National Science Council Act of 1980. The Act would have established the National Science Council to address questions of scientific fact which arise in agency adjudication involving restricted use of certain substances, primarily used in food production, processing or marketing. The subcommittee's hearing examined the proposal to establish the concept

of centralized risk analysis, to be directed by National Science Foundation's National Science Board.

June 25, 1981: James M. Beggs, former executive Vice President of General Dynamics Corporation, was confirmed as the Administrator of the National Aeronautics and Space Administration.

July 24, 1981: The Senate confirmed George A. Keyworth as director of the Office of Science and Technology Policy. Dr. Keyworth had been the physics division leader at the Los Alamos National Laboratory.

July 27, 1981: The Senate Committee on Labor and Human Resources, Subcommittee on Alcoholism and Drug Abuse held hearings to examine research programs at the National Institute on Alcoholic Abuse and Alcoholism (NIAAA) and the National Institute on Drug Abuse (NIDA). The subcommittee also examined the need for social science research on substance abuse, and the merits of transferring the NIAAA and NIDA to the National Institutes of Health.

August 10, 1981: The National Research Council of the National Academy of Sciences approved changing the name of the Committee on Science and Public Policy (COSPUP), to the Committee on Science, Engineering, and Public Policy (COSEPUP). The committee is charged "to deliberate on initiatives for new studies in the area of science and technology policy, taking especially into account the concerns and requests of the President's science adviser, the Director of the National Science Foundation, and the Chairman of key science and technology-related committees of the Congress."

August 13, 1981: Public Law 97–34, the Economic Recovery Tax Act of 1981, was signed into law. This law implemented a research and development tax credit and a tax deduction for charitable donations of R&D equipment to universities designed to stimulated R&D. The law also provided for a 25 percent tax credit for the increase in a firm's qualified R&D costs above the average expenditure for the previous three tax years.

September 23, 1981: S. 1657 (H.R. 4564), the Uniform Science and Technology Research and Development Utilization Act, was introduced to establish and maintain a uniform Federal policy for the management and use of the results of federally sponsored science and technology research and development. The Act would have directed the Secretary of Commerce to coordinate, direct, and review the implementation and administration of this policy through consultation with Federal agencies and departments. (H.R. 4564 was companion to S. 1657.)

December 10, 1981: The Subcommittee on Oversight and Investigations of the House Committee on Science and Technology began hearings on the effects of the Reagan Administration's budget policies on the long-term health of U.S. science and technology. Presidential science adviser, Dr. George Keyworth, testified that the Reagan Administration's research and development policies are tied to economic and national security issues. Dr. Keyworth also testified that the U.S. could no longer expect or afford to be world preeminent in all fields of science. He stated that, compared to basic research, "there is less justification for a Federal Government role in applied research and development, except in

areas of predominate Federal responsibility such as defense, space, or particular aspects of the regulated nuclear industry."

December 11, 1981: S.1939 was introduced to amend title IV (National Research Institutes) of the Public Health Service Act to establish a National Institute on Arthritis and Musculoskeletal Diseases. The bill proposed that the Secretary of Health and Human Services, acting through the Institute, operate separate multipurpose arthritis and musculoskeletal disease research centers.

December 29, 1981: President Ronald Reagan imposed additional sanctions on scientific exchanges between the Soviet Union and the United States, following the imposition of martial law in Poland. Subsequently, the United States did not renew its exchange agreements with the Soviet Union on space, energy, and science and technology, which expired in May, June, and July of 1982.

February 16, 1982: Dr. George Keyworth, the President's science adviser and Director of the Office of Science and Technology Policy, established the White House Science Council to assist him in examining major issues affecting various Federal science agencies and to conduct studies of major programmatic and policy issues which cut across agency responsibilities.

April 2, 1982: President Ronald Reagan signed Executive Order 12356, National Security Information, which prescribed a uniform system for classifying, declassifying, and safeguarding national security information. Executive Order 12356 reversed a 30-year trend by increasing the areas of research subject to classification. The Executive Order increased the number of categories of potentially classifiable scientific and technical information and made it possible to reclassify scientific and technical information previously released to the public.

April 29, 1982: Dr. James B. Wyngaarden, Chairman of the Duke University Department of Medicine, was appointed Director of the National Institutes of Health.

May 19, 1982: The House Committee on Science and Technology inserted language into the National Science Foundation Act for Fiscal Year 1982 and 1983 (H.R. 5842) to establish the science and engineering education directorate as a permanent entity of the Foundation, rather than as an office within the Director's Executive Office.

May 24, 1982: S. 2562 was introduced. It proposed to transfer the functions of the Department of Energy to the Departments of Commerce, Interior, Justice, and Agriculture and the Federal Energy Regulatory Commission. The legislation would have provided for the organization of energy and defense program functions and for the continuation of Federal Energy Regulatory Commission as a separate independent regulatory agency, and would have established an energy data and information program within the Department of Commerce.

July 4, 1982: President Reagan issued the first of three major space policy directives in his first term. The first, on July 4, 1982, addressed U.S. goals in space for the next decade for both military and civilian space programs. The second, on May 16, 1983, concerned the commercialization of expendable launch vehicles. Fi-

nally, on August 15, 1984, he issued his National Space Strategy which essentially implemented his other policy directives and reaffirmed his commitment to build a permanent manned space station within a decade as he had stated in his 1984 State of the Union Address. Although originally it had been planned for the National Space Strategy to enunciate long-term U.S. space goals, the President left development of those goals to the newly established National Commission on Space, whose report is due in 1986.

July 22, 1982: Enactment of Public Law 97-219, the Small Business Innovation Development Act of 1982, was designed to strengthen the role of the small, innovative firms in federally funded research and development, and to utilize Federal research and development as a base for technological innovation to meet agency needs and to contribute to the growth and strength of the Nation's economy. Each Federal agency with an extramural research and development budget in excess of $100 million is required to establish a small business innovation research (SBIR) program, and to set aside annually 1.25 percent (phase in over a four year period; 5 years for DOD) of the agency R&D budget to fund the SBIR program.

August 4, 1982: S. 2809, the National Science and Technology Improvement Act of 1982, was introduced. It would have established in the Executive Office of the President a presidential program for the improvement of science and technology to be administered by the Office of Science and Technology Policy (OSTP). The Act would have directed OSTP to assess particular problems of science and engineering manpower improvement, and to upgrade academic research in the physical and biological sciences.

December 21, 1982: Enactment of Public Law 97-375, the Congressional Reports Elimination Act of 1982, in which section 214, amended the National Science Foundation Act of 1950. It requested NSF's National Science Board to submit a report on January 15 of each even numbered year, on indicators of the state of science and engineering in the United States. The law also amended the National Science and Technology Policy, Organization, and Priorities Act of 1976 (P.L. 94-282), instructing the Director of OSTP to prepare and present to Congress by January 15 of each odd numbered year a combined science and technology report and outlook.

January 6, 1983: H.R. 481 was introduced. It proposed the establishment of the National Technology Foundation to foster communication between scientific and technological agencies of the Federal Government and the small business community, operate programs of grants for the development of high-technology, and collect, analyze, and publish information concerning grants and contracts awarded to small businesses. The Act called for the reorganization of several Federal agencies which would comprise the actual foundation.

January 7, 1983: Public Law 97-425, the Nuclear Waste Policy Act of 1982, was signed. It authorized Department of Energy to select, build, test, and evaluate repositories for the disposal of high-level radioactive waste and spent nuclear fuel. The Act also instructed DOE to establish a program of research and develop-

ment to focus on such issues as technical licensing requirements, validating scientific models, evaluating and testing waste handling systems, and establishing repository operating capability.

February 22, 1983: S. 540, the Health Research Extension Act of 1983 was introduced. The legislation would have created a new National Institute of Arthritis and Musculoskeletal and Skin Diseases and a new National Institute of Nursing. The legislation also would have required the Secretary of Health and Human Services to review NIH research programs.

March 10, 1983: President Ronald Reagan established the U.S. Exclusive Economic Zone (EEZ) for the oceans that asserted jurisdiction over marine resources in an area of about 3.9 billion acres, an area extending seaward 200 nautical miles for the baseline from which the U.S. territorial sea is measured. Within the zone, the United States claimed "sovereign rights for the purpose of exploring, exploiting, conserving, and managing natural resources, both living and nonliving, of the seabed and subsoil and the superadjacent waters, and for protection of the marine environment." The EEZ Proclamation followed in the wake of the President's decision that the United States would not sign the Third United Nations Treaty on the Law of the Sea.

March 23, 1983: In a nationally televised address, President Ronald Reagan called on the scientific community to develop the means to render nuclear weapons "impotent and obsolete" by performing R&D on a new ballistic missile defense system. Since some of the components for the system might be based in space, the media dubbed this the "Stars Wars" speech. In March 1984, a new office was created in the Office of the Secretary of Defense to administer the program, which is officially called the Strategic Defense Initiative (SDI), with the SDI director reporting to the Secretary.

April 15, 1983: Dr. Edward A. Knapp was confirmed by the Senate as the Director of the National Science Foundation. Dr. Knapp was the former division leader at the Accelerator Technology Division at the Los Alamos National Laboratory.

April 19, 1983: The Agency for Toxic Substances and Disease Registry was established within the Public Health Service by the Secretary of Health and Human Services as required by section 104(i) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Public Law 98–80), better known as the Superfund. The mission of the Agency is to lead and direct programs and activities for the protection of the health and safety of workers and the public from the adverse effects caused by exposure to hazardous substance in storage sites or released by fires, explosions, or transportation accidents.

May 11, 1983: H.R. 2969 which authorized appropriations for the Department of Defense for fiscal year 1984 was introduced. House Report 98–107 which accompanied H.R. 2969 requested DOD to conduct a comprehensive study to analyze the need to modernize university laboratories in which the Department of Defense research programs are conducted.

September 30, 1983: H.R. 4043, the Research and Development Joint Venture Act of 1983 was introduced to modify the operation of the antitrust laws to encourage the formation of re-

search and development joint ventures in order to increase the effectiveness of technology development and to improve the economic competitiveness of the United States. The legislation also would have provided for antitrust law immunity (including both civil and criminal) for joint R&D ventures that comply with its requirements. (This legislation was signed into law on August 11, 1984 (P.L. 98-462).)

October 14, 1983; December 20, 1983; and March 30, 1984: Executive Orders 12444, 12451, and 12470, respectively, signed by President Ronald Reagan, to extend the legislative provisions of the Export Administration Act of 1979 (EAA), which had an original expiration date of September 30, 1983, but was granted one-year extension by Congress. The EAA has been the principle regulatory instrument of the Reagan Administration to control the flow of senstive technical data from the U.S., primarily to the Soviet Union and its allies.

October 19, 1983: Public Law 98-507, the National Organ Transplant Act was enacted. It directed the Secretary of Health and Human Services to establish a task force on Organ Procurement and Transplantation.

October 26, 1983: The Senate rejected, by a vote of 56-40, an amendment to a supplemental appropriations act (P.L. 98-191) that would have provided funds to continue the Clinch River Breeder Reactor Project, one of the most controversial nuclear energy demonstration projects Congress has ever supported.

November 10, 1983: H.R. 4361, the Advanced Technology Foundation Act was introduced. The Act would have established in the executive branch an advanced technology foundation to initiate and support applied scientific research and development programs directed at facilitating the movement of basic scientific concepts into commercial products.

December 8, 1983: The Grace Commission released a number of reports on cost containment within the Federal Government. The Research and Development Task Force report proposed a number of recommendations for cost savings in the area of federally sponsored R&D in support of President Reagan's goal of reducing overall Government expenditures.

December 15, 1983: The DOD-University Forum was chartered as a Department of Defense advisory committee. The purpose of the Forum is to help bring a new awareness to the defense community of the vital role which the Nation's university research and education programs play in maintaining the country's economic and military strength. The DOD-University Forum is jointly sponsored by DOD and three higher education associations: the Association of American Universities, the National Association of State Universities and Land Grant Colleges, and the American Council on Education.

December 28, 1983: The Secretary of State, George P. Schultz, notified the Director-General of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) that the United States was terminating membership in the organization effective January 1, 1985. The Secretary stated that the decision had been made because UNESCO has "extraneously politicized virtually every subject it deals with; exhibited hostility toward the basic

institutions of a free society, especially a free market and a free press; and demonstrated unrestrained budgetary expansion."

January 15, 1984: The National Academy of Sciences officially approved the establishment of the Government-University-Industry Research Roundtable. The roundtable was created to provide a forum where scientists, engineers, administrators, and policy makers from Government, universities, and industry could come together on an ongoing basis to explore ways to improve the productivity of the Nation's research enterprise.

January 25, 1984: In his State of the Union address, President Reagan directed NASA to develop a permanently manned space station within a decade and said that such a program would permit "quantum leaps in our research in science, communications, and in metals and life saving medicines which can be manufactured only in space." He also said that NASA would invite other countries to particpate in the project.

February 24, 1984: Executive Order 12465 authorized the Department of Transportation to be the lead agency within the Federal Government for encouraging, facilitating, and coordinating the commercial development of expendable launch vehicles (ELVs) within the United States private sector. The action came after more than a year of debate over which Government agency should have responsibility for commercial space operations now that NASA is phasing out the use of ELVs in favor of the shuttle, and some private companies want to market the ELVs as an alternative to the shuttle.

May 31, 1984: S. 2723, authorized appropriations for fiscal year 1985 for the Department of Defense. Senate Report 98–500 which accompanied S. 2723, requested DOD to report "on DOD activities and plans to support the United States infrastructure for science and engineering education and research." The Senate Armed Services Committee indicated that the report "should address the role of DOD in the education and training of engineers and sciences for technologies used by DOD."

June 6, 1984: The House Committee on Agriculture, Subcommittee on Department Operations, Research, and Foreign Agriculture began four days of hearings on research, extension services, and higher education. This was the first time that all three parts of the public agriculture system have been addressed in order to develop a broad consensus on the major research needs and opportunities facing the food and agricultural systems in the coming decades.

June 20, 1984: The House Committee on Science and Technology, Subcomittee on Science, Research, and Technology and the House Committee on Agriculture, Subcommittee on Departmental Operations, Research and Foreign Agriculture, held a joint hearing on H.R. 4684, the National Nutrition Monitoring and Related Research Act of 1984. The bill was designed to establish a national nutrition monitoring and related research program, including the establishment of a coordinated comprehensive nutrition monitoring system between the U.S. Department of Agriculture and the Department of Health and Human Services.

June 3, 1984: Congressman Don Fuqua, Chairman of the House Committee on Science and Technology, announced the establish-

ment of a 18 member Science Policy Task Force, composed of members from both political parties. The task force is involved in a two-year comprehensive study of past, current, and future science policy issues for the Nation. According to Congressman Fuqua, the agenda for the two-year study includes: the institutional framework for the support and conduct of scientific research; the training and education of young scientists; research funding methods; and the overall funding level for science.

June 31, 1984: Public Law 98–373, the National Materials and Minerals Policy, Research and Development act was signed. The law established a National Critical Materials Council within the Executive Office of the President. Among the Council's responsibilities is coordination with appropriate agencies and departments of the Federal Government relative to Federal materials research and development policies and programs. The Act also established a Federal program for advanced materials research and technology, including basic phenomena through processing and manufacturing technology, and sought to stimulate innovation and technology utilization in basic, as well as advanced, materials industries.

August 2, 1984: Congressman Don Fuqua, Chairman of the Task Force on Science Policy opened the first of many meetings and hearings of the 18 member task force in its review of U.S. science policy. During his opening statement Chairman Fuqua indicated that, "our aim will be to review the evolution of Federal science policy since the Bush report of 1945; to determine the results of these policies and the current state of U.S. science; and to try to determine the longer range needs of U.S. science and the adequacy of our policies for government support of science."

August 6, 1984: Erich Bloch was confirmed by the Senate as the next director of the National Science Foundation (NSF). Mr. Bloch is the first Director of NSF to come from industry, rather than a university or Federal research laboratory. Mr. Bloch had been vice president for operations at IBM Corporation.

August 11, 1984: Public Law 98–377, the Education for Economic Security Act provided assistance to improve elementary secondary, and postsecondary education in mathematics and science. The Act also included a national policy for engineering, technical, and scientific personnel and provided for cost sharing by the private sector for the training of such personnel.

August 11, 1984: Public Law 98–462, the National Cooperative Research Act of 1984 was signed into law. The law established a system where joint ventures on research projects can limit potential legal liability for violation of antitrust laws to actual damages incurred by an injured party. Further, the Act allows firms engaged in joint ventures to be reimbursed for their costs in defending themselves in frivolous lawsuits brought against them under the antitrust laws.

September 27, 1984: The Chairman of the National Science Board established an ad hoc Committee on Excellence in Science and Engineering to study why some educational institutions are attempting to bypass merit-based review to secure funds for research and equipment through the legislative process.

October 12, 1984: President Reagan issued Executive Order 12490, establishing a National Commission on Space, made up of a 15 member board, appointed by the President. The Executive Order, directed the Commission to study existing and proposed U.S. space activities, formulate an agenda for the U.S. civilian space program, and identify long range goals, opportunities, and policy options for civilian space activities for the next 20 years.

October 30, 1984: Public Law 98–575, the Commercial Space Launch Act was enacted. The Act was designed to facilitate the launches of commercial expendable launch vehicles (ELVs). The Act designated the Department of Transportation (DOT) as the lead agency for the commercialization of expendable launch vehicles. DOT is responsible for developing licensing requirements tailored to the commercial launch process, issuing and enforcing licenses, and assisting industry in the acquisition of space technology.

November 11, 1984: Public Law 98–620, the Trademark Clarification Act of 1984 was enacted. Title V of the Act allows Government-owned, contractor-operated (GOCO) laboratories, operated by universities, to make decisions at the laboratory level regarding the award of licenses for laboratory-generated patents. The Act also permits private companies, regardless of size, to obtain exclusive license for the full life of the Government patent. Prior restrictions on large firms allowed exclusive license for any 5 of the 17 years of the patent.

November 15, 1984: The Institute of Medicine (IOM) of the National Academy of Sciences released the report of its 18-month study, "Responding to Health Needs and Scientific Opportunity; the Organizational Structure of the National Institutes of Health." The IOM study committee concluded that the current NIH structure is effective and that there should be a presumption against the creation of new categorical institutes.

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